Controlled Studies of the YSGG Laser on Bone

Dr. med. dent. Harald Passow, MSc
Berlin, Germany, 2007

All results and pictures are reported without any manipulation.

The studies are done without sponsoring of any company.

This is my hobby and retreat room.

There is nothing in dentistry, that you could not use lasers for!

But we should search for new and more comfortable and treatments for our patients.

That is a challenge for the innovative thinking dentist.

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Effect of ErCr-YSGG-Laser on Bone Structure under Controlled Experimental Conditions

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Following laser was used for the experiments:

Manufacturers:	Biolase Technology Inc., Irvine/Cal., USA
Norm:	Biolase Millennium
Laser class:	IV
Media:	HE, CR: Y S G G (erbium, Chromium, Yttrium, scandium, gallium Garnet)
Wave length:	2780 nm
Frequency:	20 c.p.s.
Performance exactness:	20 %
Pulse energy:	0 ... 300 mJ
Pulse duration:	140 ... 150 µs
Specimen angle:	Default: 90°
Tip Size:	200 ... 750 µm
Ray enlargement:	8 %
Mode:	Multi-mode
Pilot ray:	Laser diode, laser class I, 655 nm
Hazard distance:	5 cm (NOHD)

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My laser fleet in my practice:

NDYAG-Laser

Biolase Millennium

Biolase MD

Aus der Abteilung für Umwelt- und Medizinische Wissenschaften,
Zentrum für Interdisziplinäre Zahnmedizin
der Donau-Universität
Krems, Österreich

Konstruktion einer Standardversuchsanordnung zu kontrollierten Laserstudien an Geweben

Erste Studien und Ergebnisse
an menschlichem Knochenmaterial

Masterthese

zur Erlangung des
„Master of Science Implantologie" (MSc)

vorgelegt von

Harald Passow aus Berlin

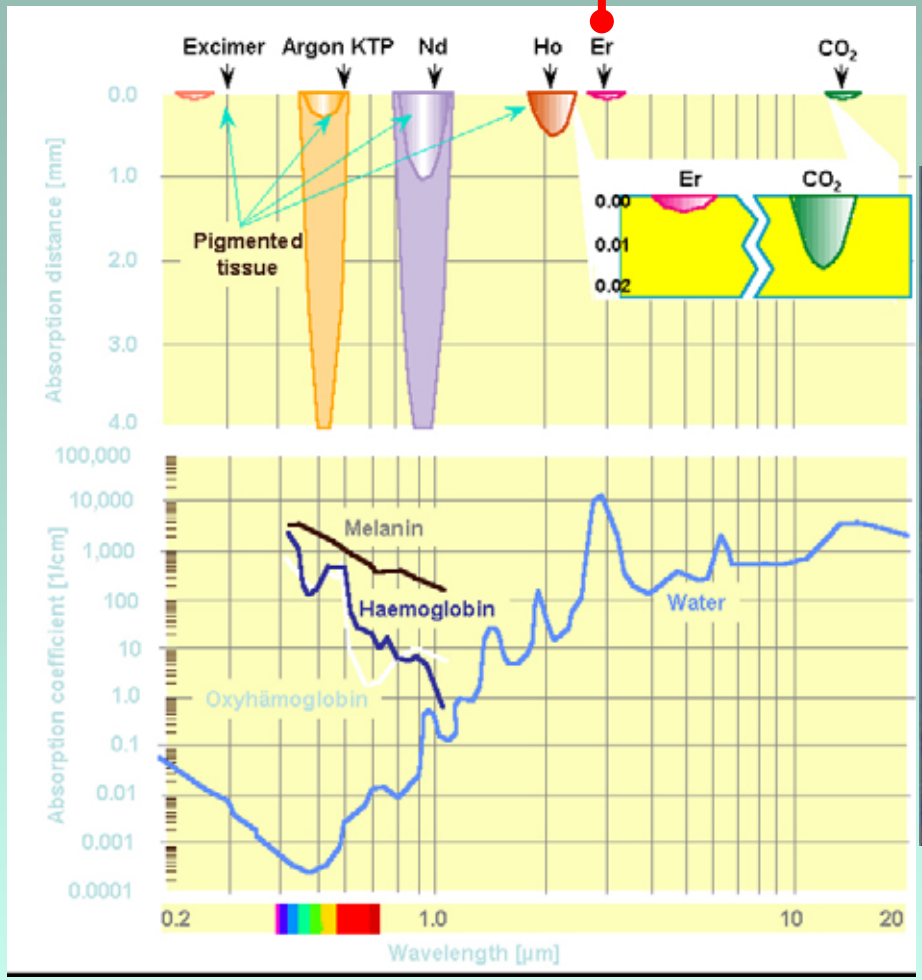
Berlin 2005

This lecture will shows cases from my master thesis which I obtained my MSc. Implantology to the Donau-University Krems, Austria.

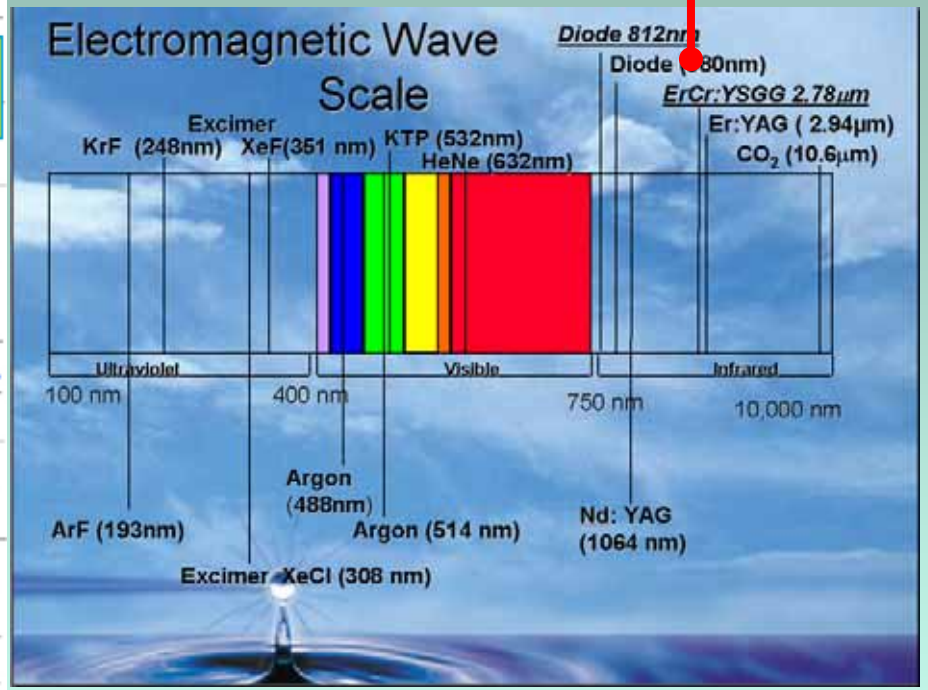
The described results are not yet published, but are being prepared for publication.

This idea and development is subject matter of registered German utility model No. 20 2005 000 844.3

ErCr:YSGG Laser 2,78 µm



ErCr:YSGG Laser 2,78 µm



These images illustrate the different wave lengths most often used laser in dentistry.

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There are indeed a great deal published case reports, but these are very subjective.

They show that they work on human tissue, but not how or why.

To eliminate subjectivity, I attempted to standardize my examinations.Therefore I developed this construction.

This standardization enabled me to test different lasers and their effects on hard tissue. In addition test studies on soft tissue and implants were also possible with slight modifications.

With these studies I was able to document the effects of the Waterlase on bone with constant parameters.

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Methods und Material

First the method:

Controlled Studies

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The preparation must be able to be moved in X and Y axis.

The control cannot be accomplished “by hand”. It must take place by means of stepping motors and be absolutely reproducible.

The movement of the workbench and the drive by stepping motors must do an even movement of the preparation,
i.e. that respective feed motion over the x- and/or y-axis must run harmoniously and without any jerk.

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A computer must be used to control the laser beam, which transfers variable control programs to the step motors.

Supplementing water and air supply should be possible as an extension of the experimental assembly.

Suction of the resulting liquids must be possible.

The mounting of different hand pieces of various lasers for comparative investigations should be easy to apply.

The control programs must be able to copy temporal hand guidance.

A step motor control should be later possible to vary the ups and downs of the laser hand piece over the object (bone, tooth, etc.).

The equipment is designed in such a way that not only hard-tissue, but also soft tissue can be examined.

Experiments can also be carried out on the decontamination of infected implants.
(The Waterlase does cause heat in implants.)

Investigation for the weakening of the Compacta as pre-treatment at the spot of the pilot drilling (easy and safe guidance for arranged implant bed preparation).

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Since human tissue is available due to the withdrawal areas only limited,
it should be possible to treat tissue parts
of 2 x 2 cm several times.

With different tool holders various lasers can be tested on the same tissue (optimal comparability of the results).

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Short Description of the Experimental Assembly

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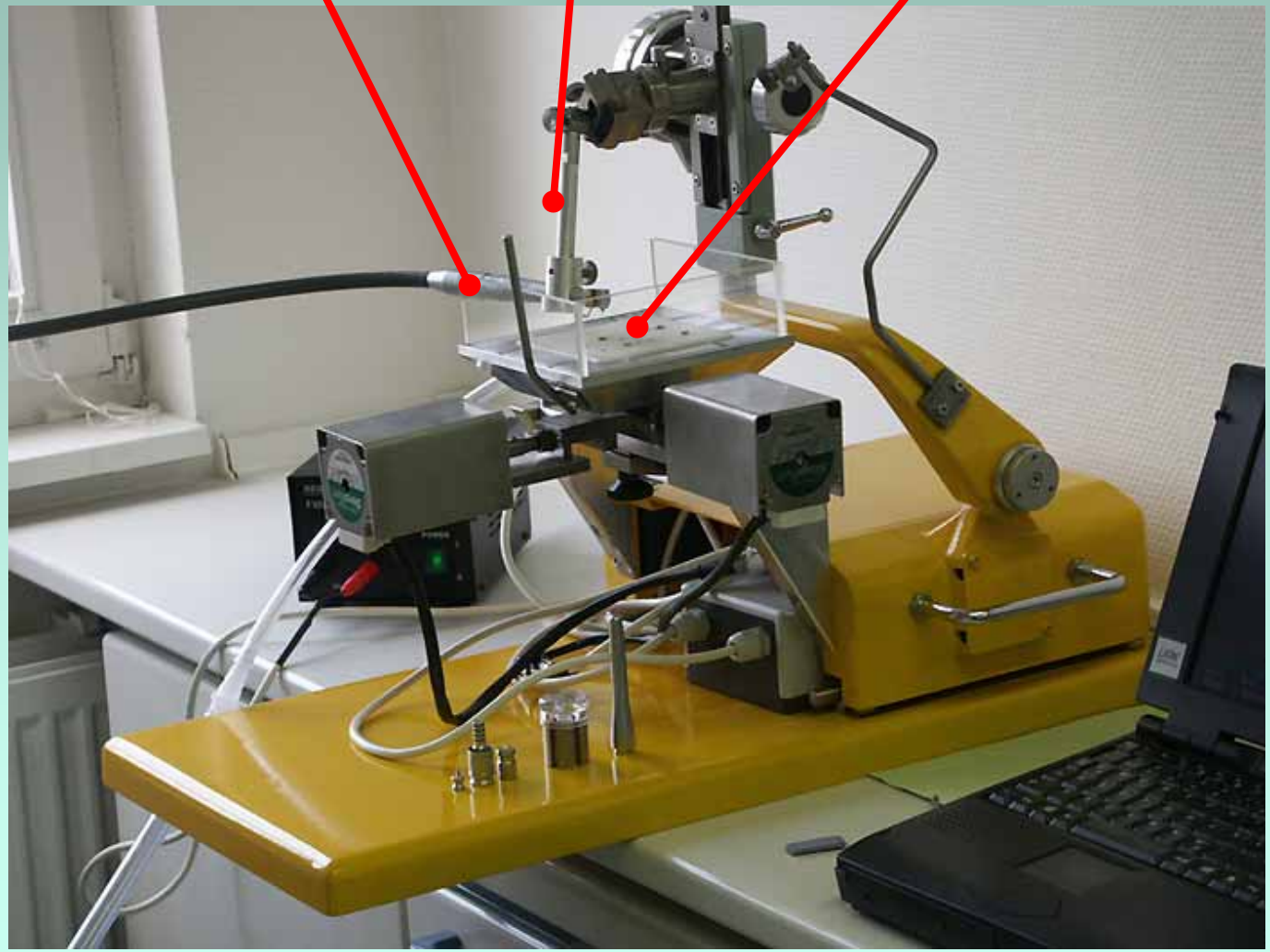
Tool holder

Laser hand piece

Table for the bone preparations



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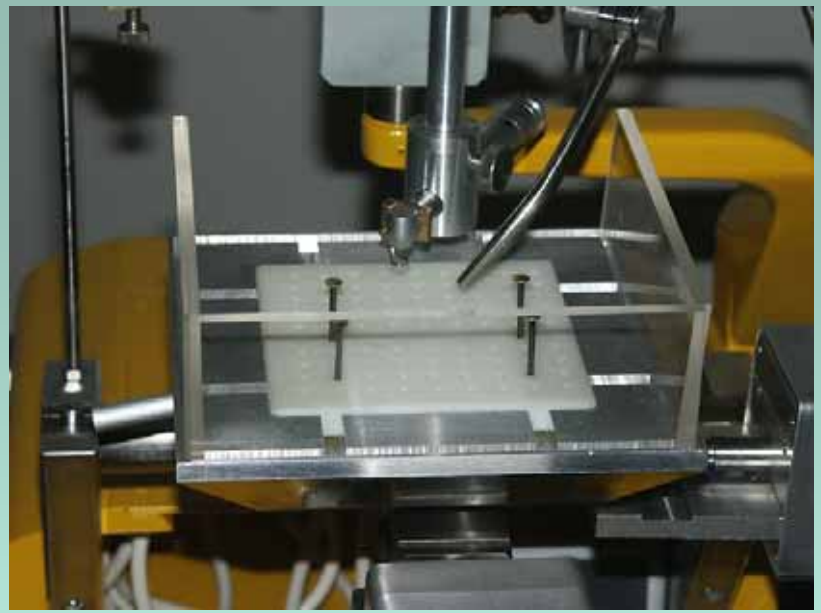
Details of the experimental assembly.



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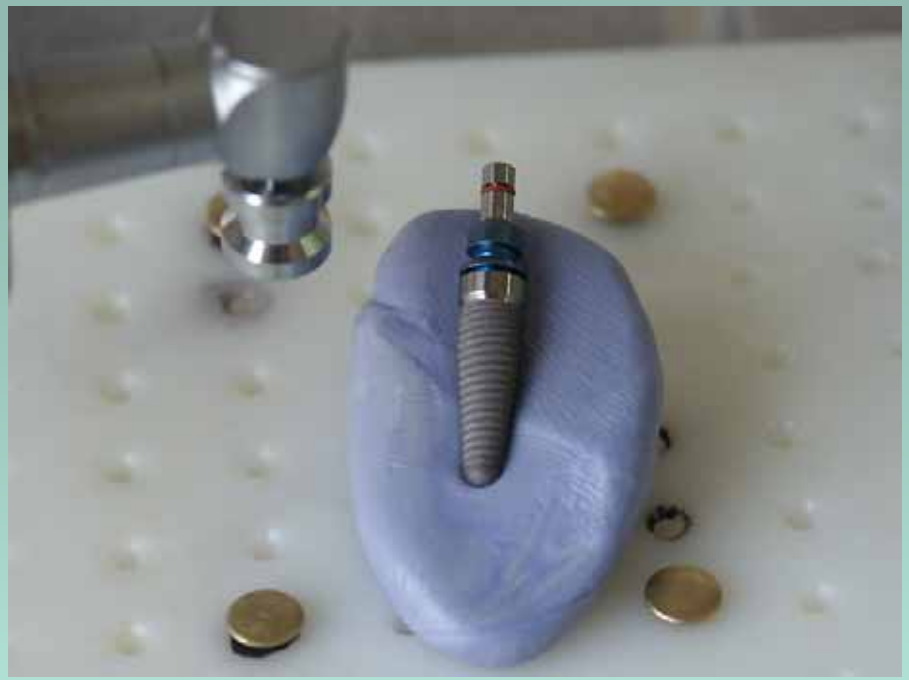
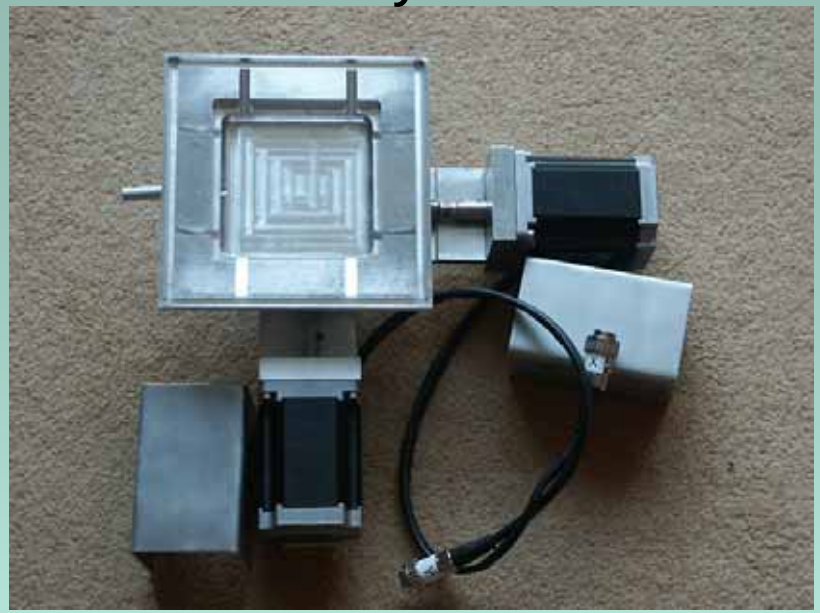
Examples of materials on the preparation table to be researched

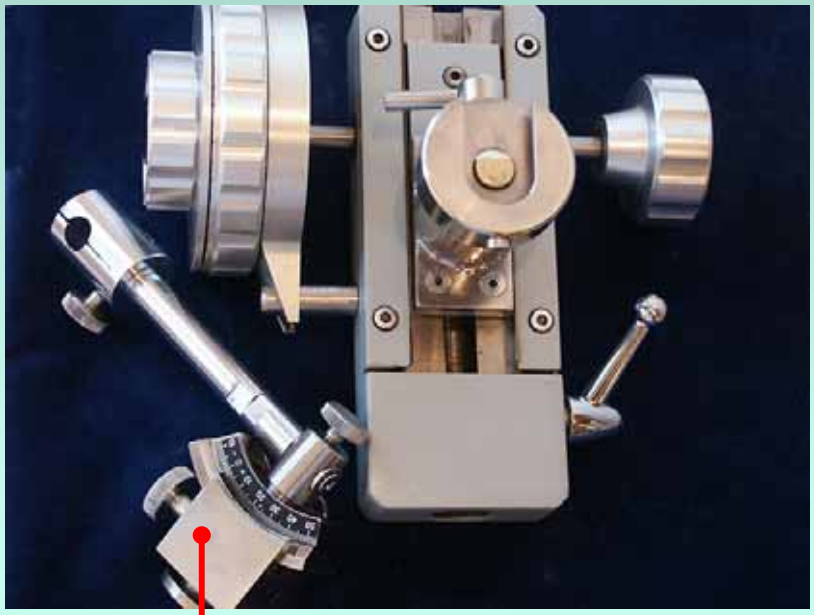


H. Passow

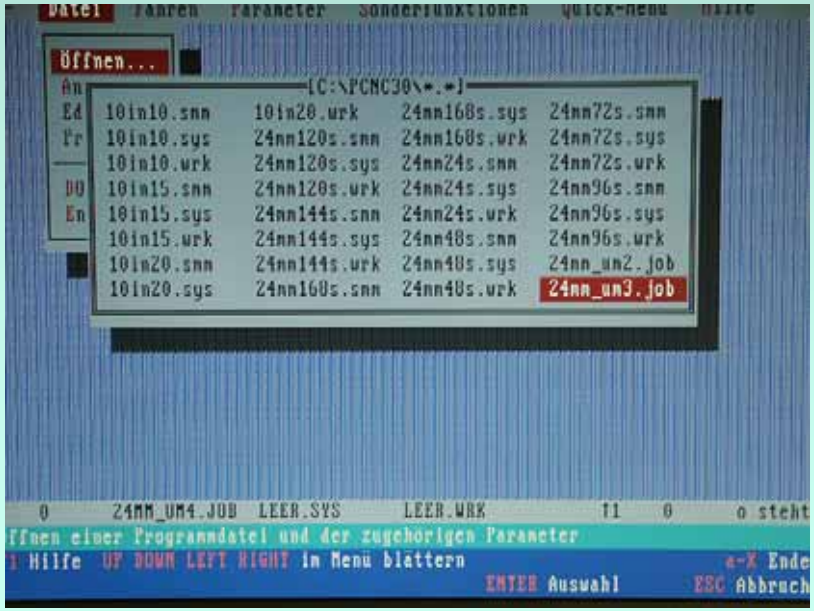
Here you see other details of the experimental assembly

All positions 360° change-able.





Tool for changing the angle.



Screen shot of the Control program

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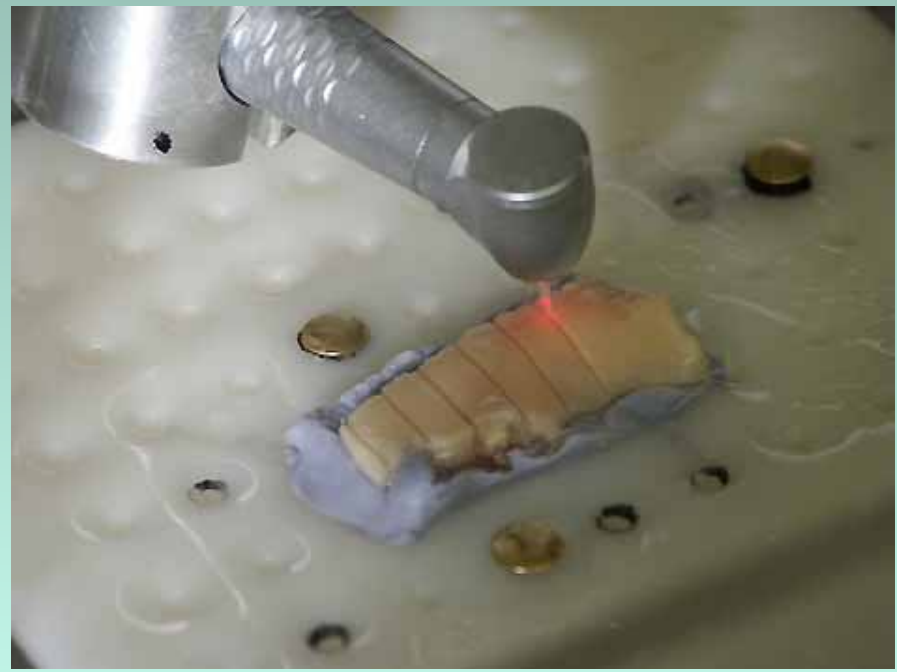
Complete experimental assembly



Laser in working position over a bone

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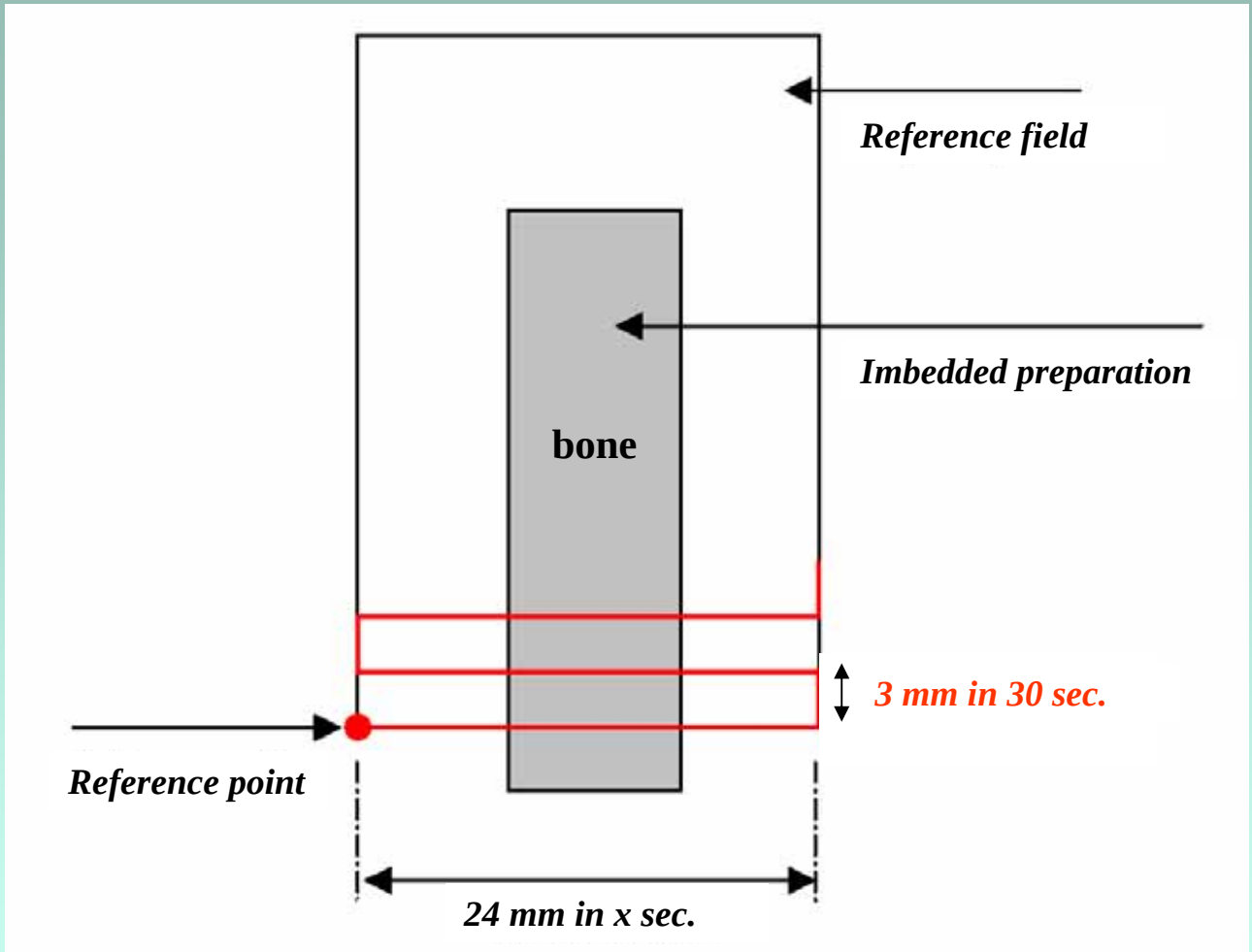
The table with the preparation runs in horizontal and vertical direction.

A computer program controls the micro motors in 0.01 mm steps.

Example



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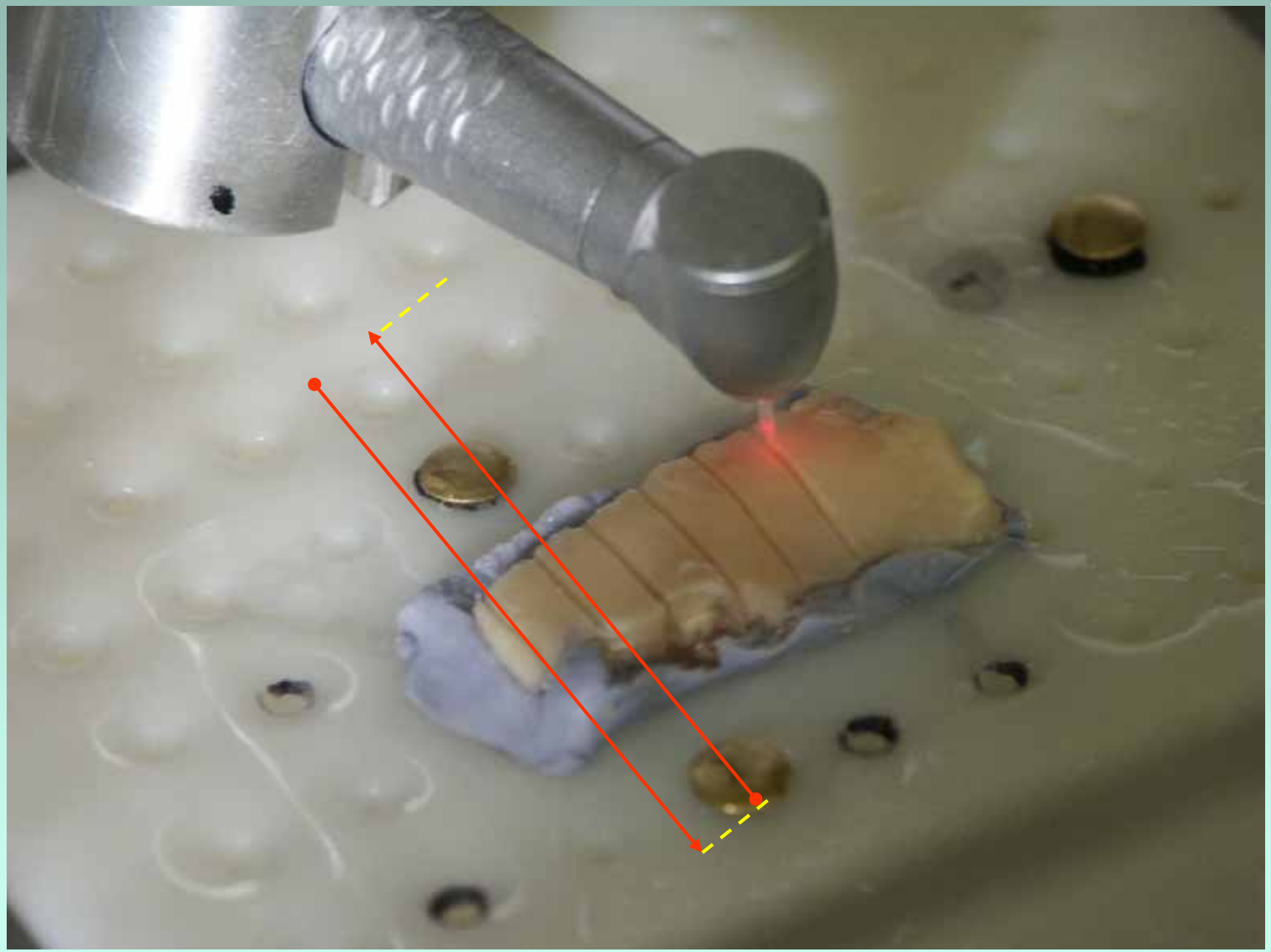
Laser in working position over imbedded preparation



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Material

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At this point I would like to thank
Mr. Professor Dr. med. Klaus-U. Benner,
Anatomic Institute of the
Ludwig-Maximilians-University,
Munich, Germany
for the materials and histological
investigations.

Adjustment of the Laser Hand piece

First the laser hand piece was aligned to an angle of 25° to the preparation, and a reference point was specified.

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Now we start ...

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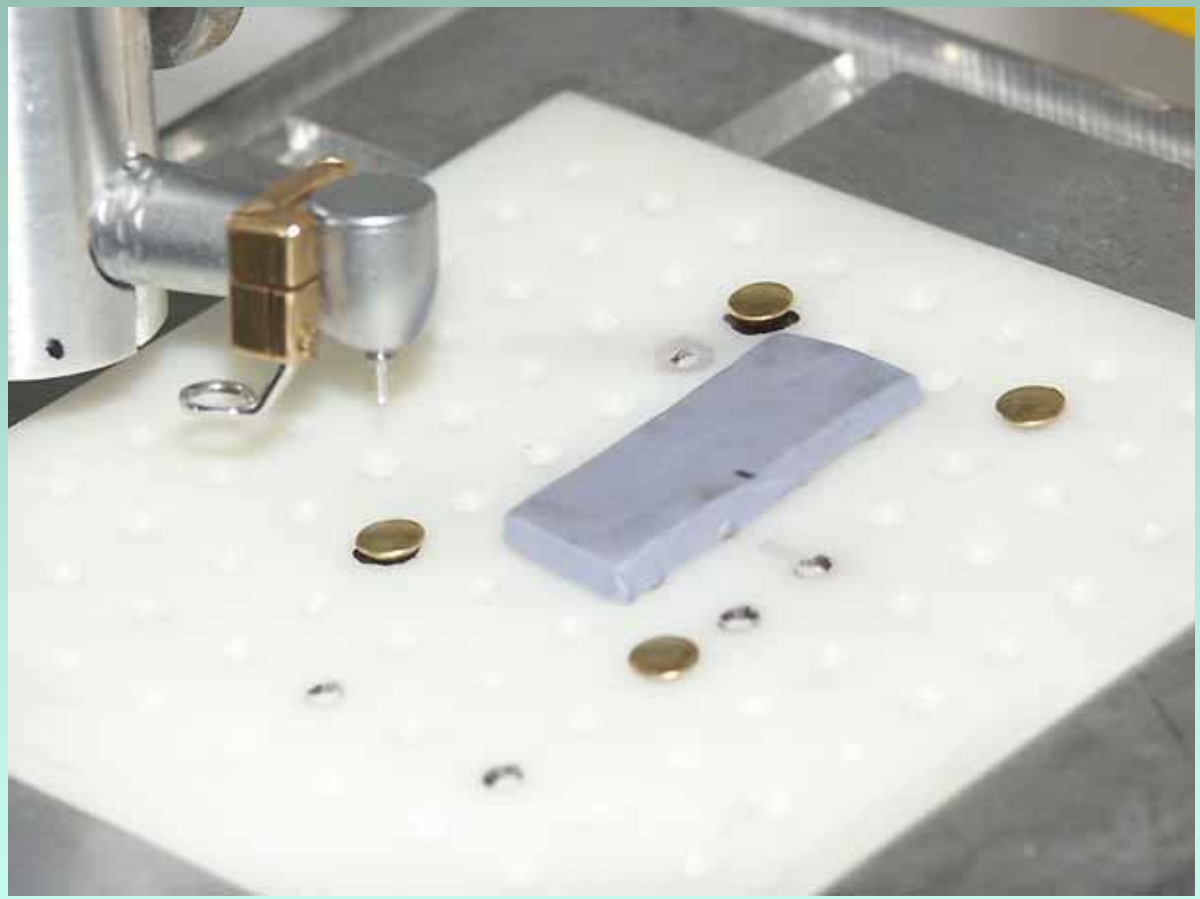
Definition of the reference field and the reference point



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Preparation of the Material

Very small parts of unfixed human bones from upper and lower jaw were taken for the laser studies.

The temperature of the bones were increased from 4° C to room temperature to 24° C before using.

The bone sample was imbedded on the preparation table in silicone.

Conditions for the Following Experiment

Distance of the laser work point:
(600 µm sapphire tip) 3 to 3,5 mm

Laser Setting:
5 Watt
Water 75 %
Air 95 %

Angle of the laser point to the preparation 25°.

Different movements with the laser hand piece.

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Macroscopic Examples of Treated Bones from Jaws

B2, A4, and A3 is upper jaw.

A1 and B1 is lower jaw.

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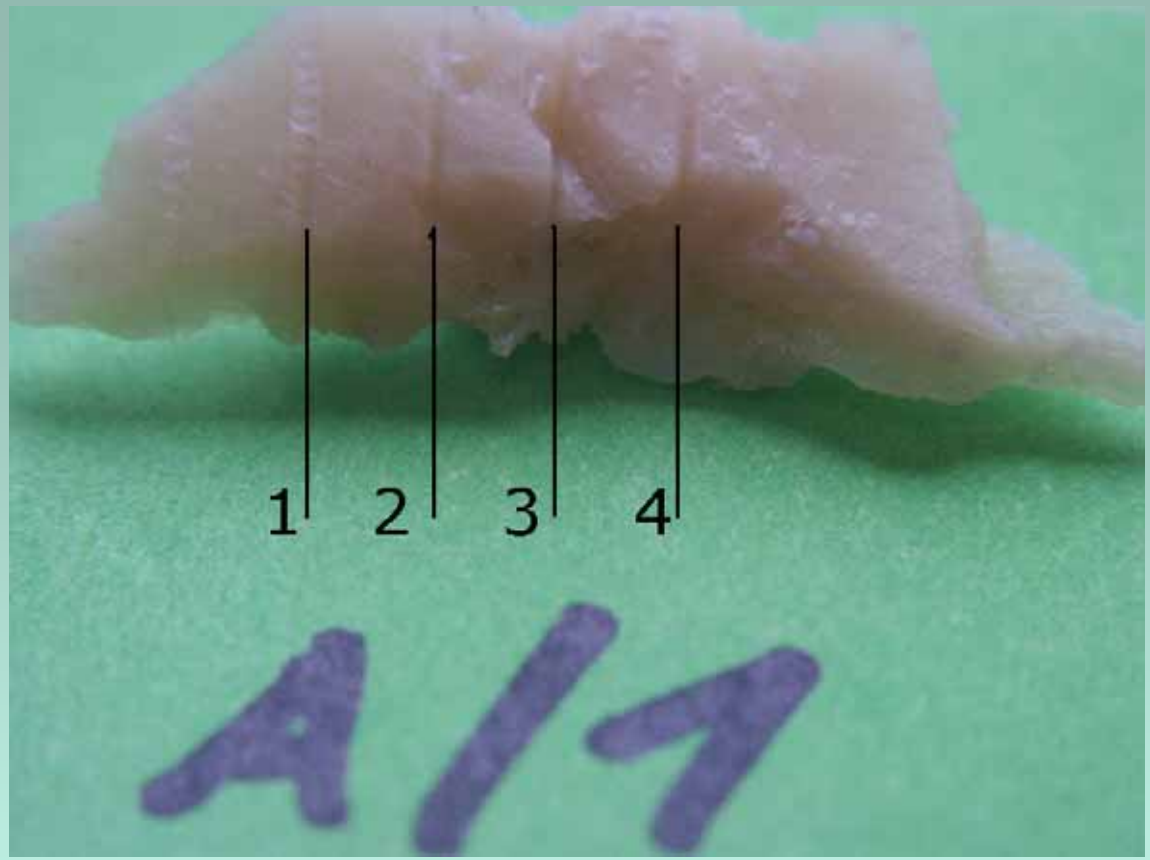
For microscopic histological evaluation the preparation A1 was selected.



Distance of the laser work point : (600 µm Sapphire)
3 to 3.5 mm

Laser Settings
5 Watt
Water 75%
Air 95%

Working planes 1 to 4:

1 = 1 mm/2 sec.
2 = 1 mm/3 sec.
3 = 1 mm/4 sec.
4 = 1 mm/5 sec.

Angle of the laser point to the preparation 25°

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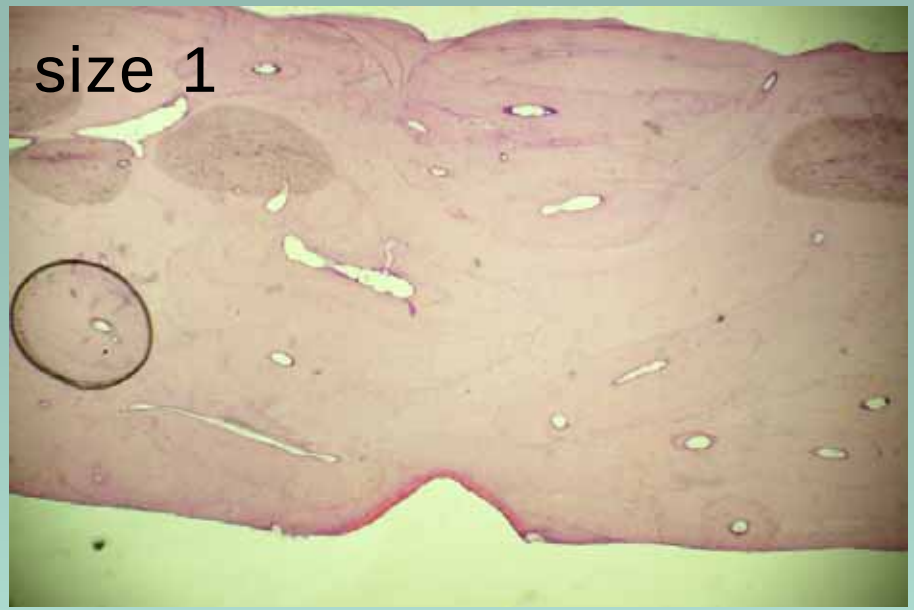
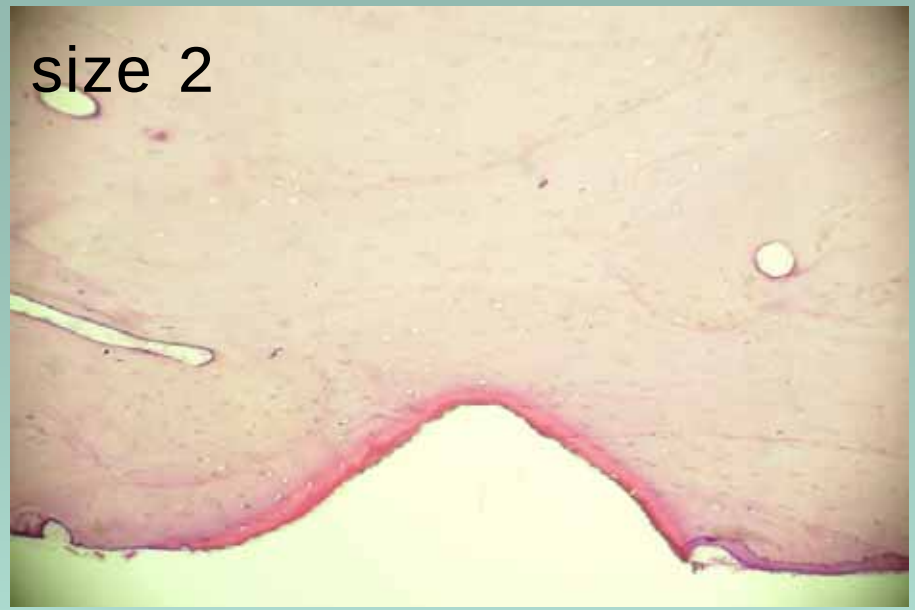
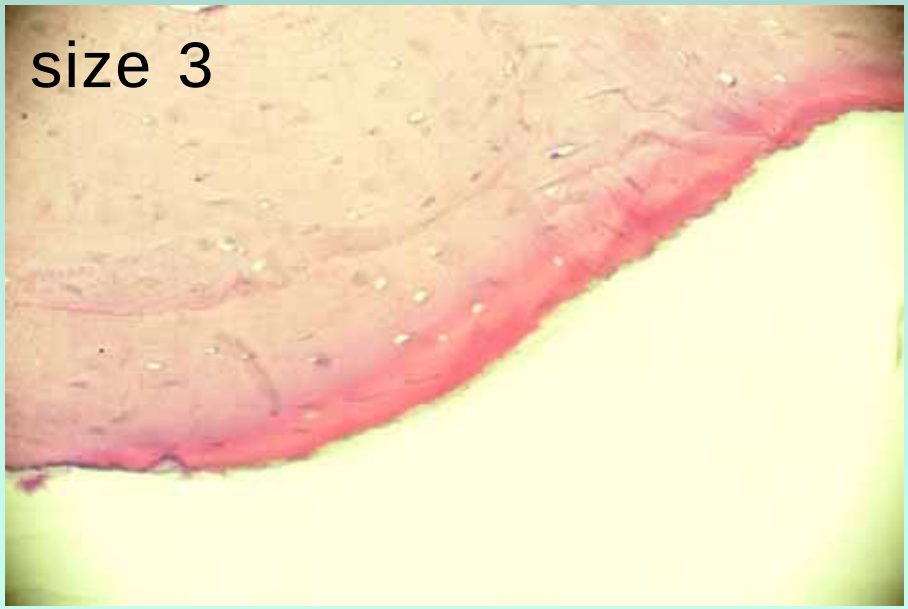
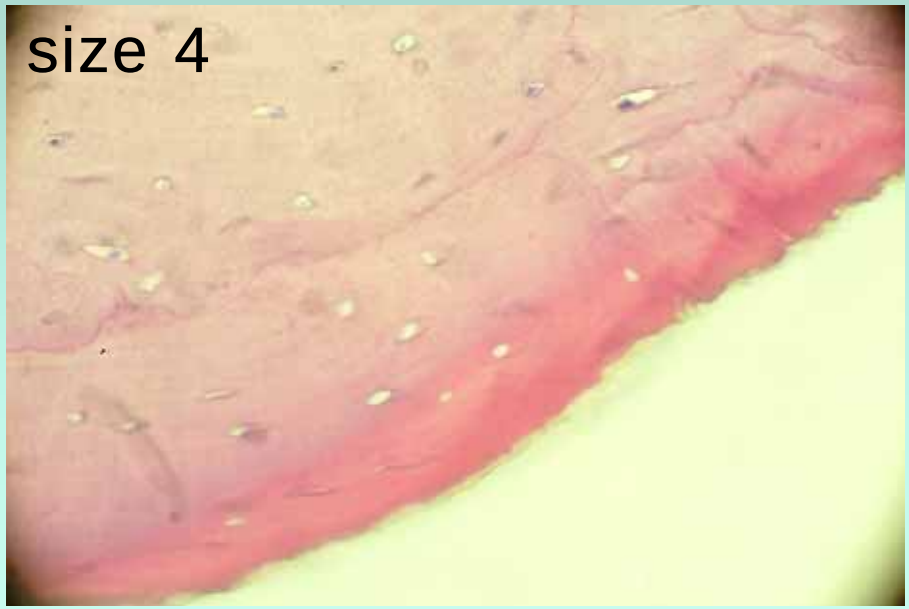




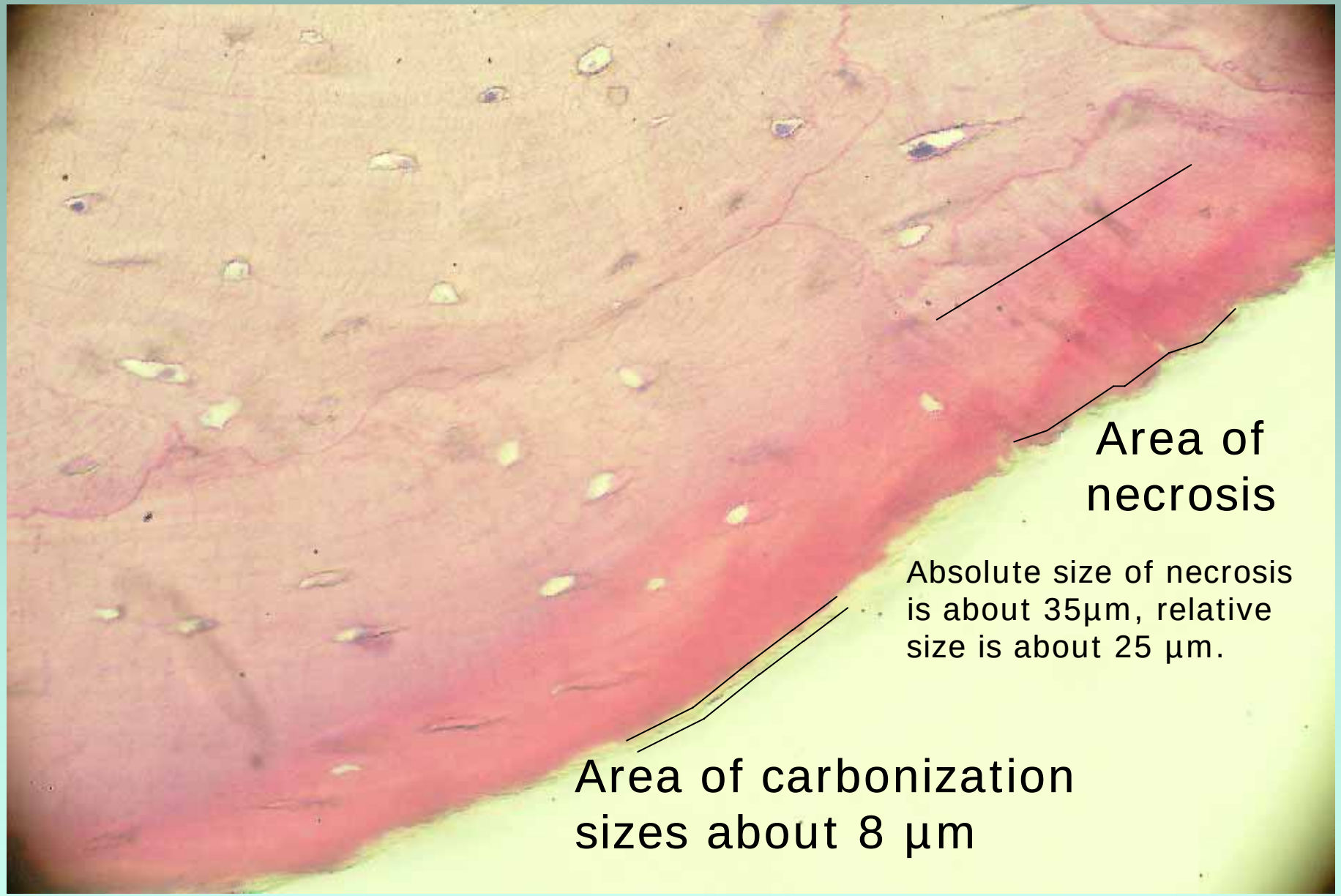




Working Plane 1

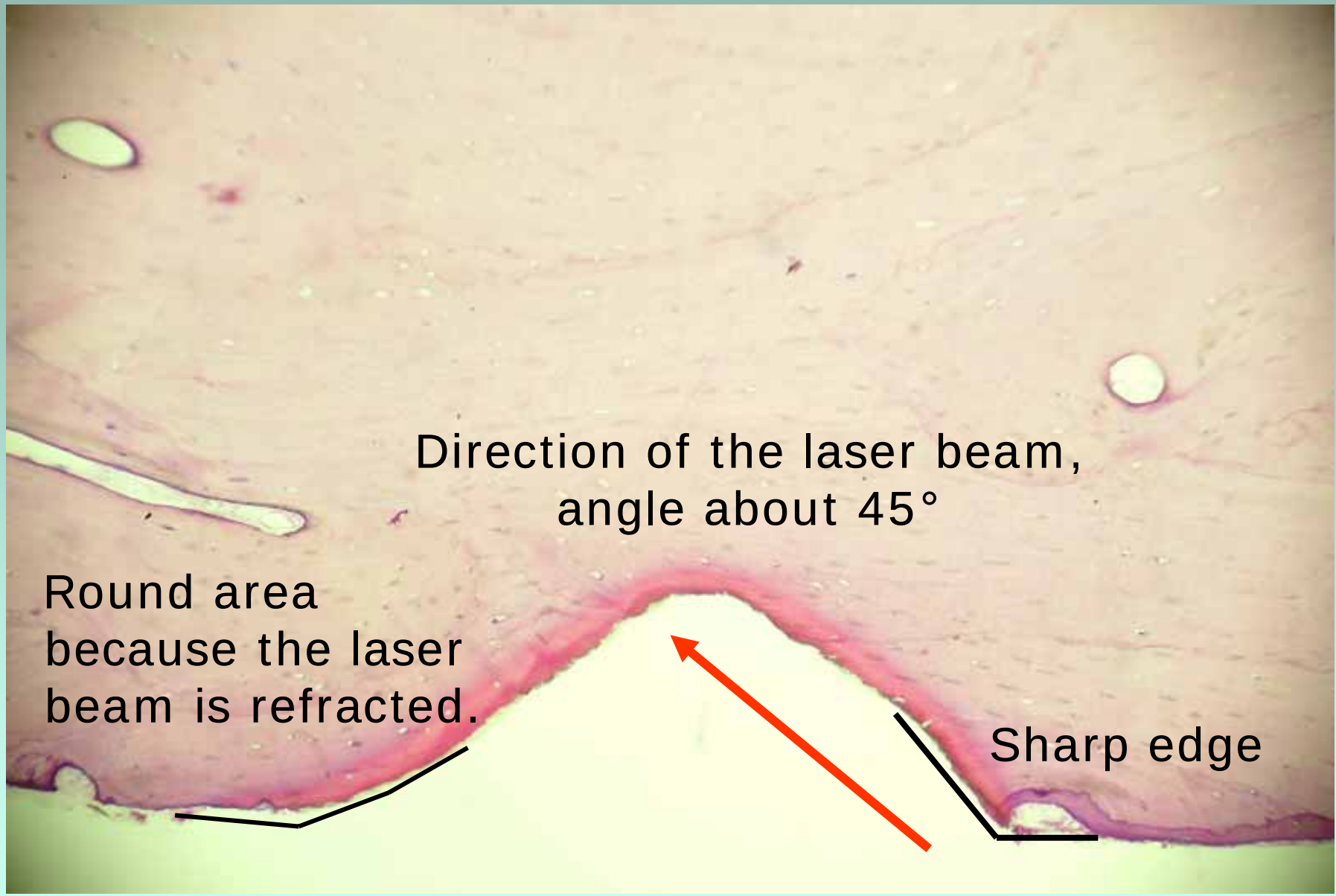
Movement of laser beam was 1 mm in 2 seconds.

HP



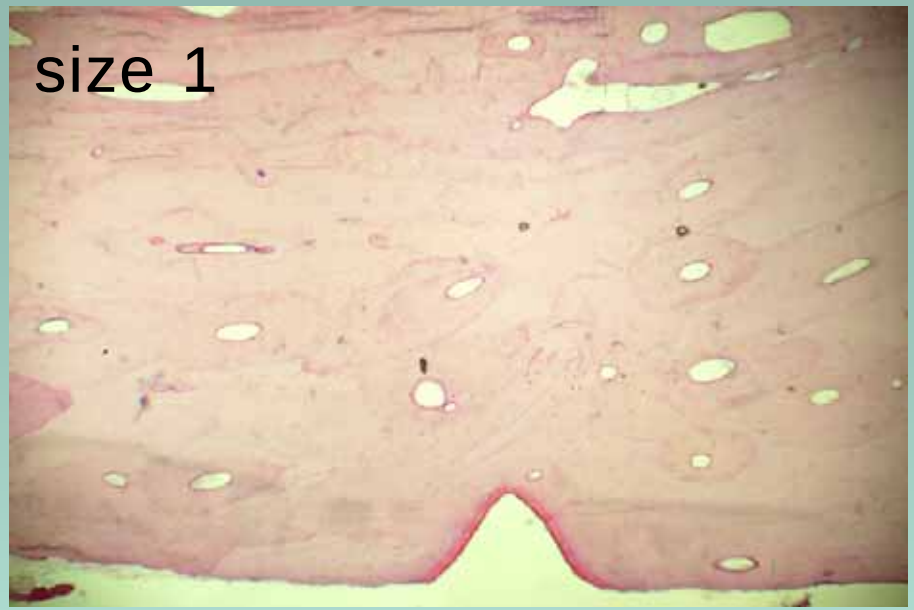
Working Plane 1, size 4
laser beam movement 1 mm/2 sec.

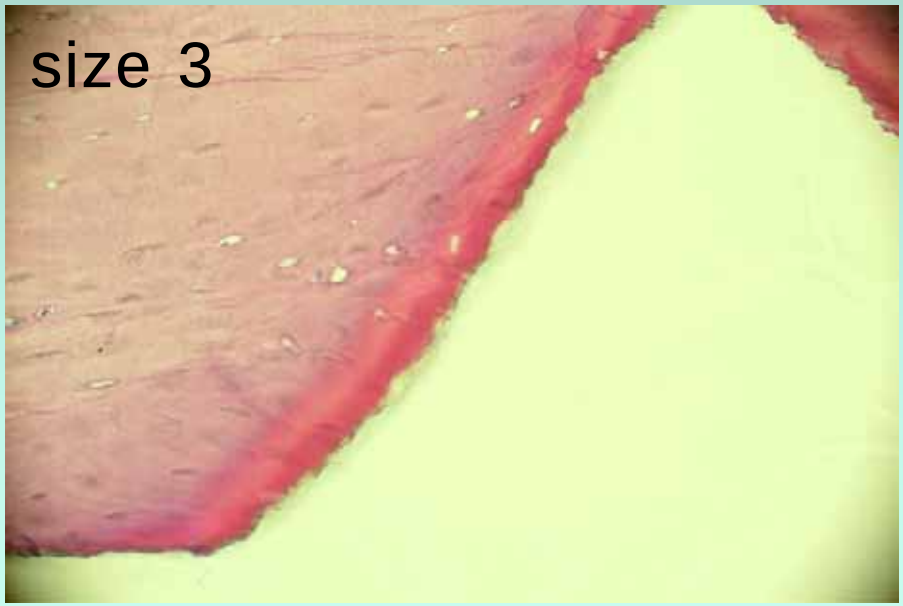
H. Passow

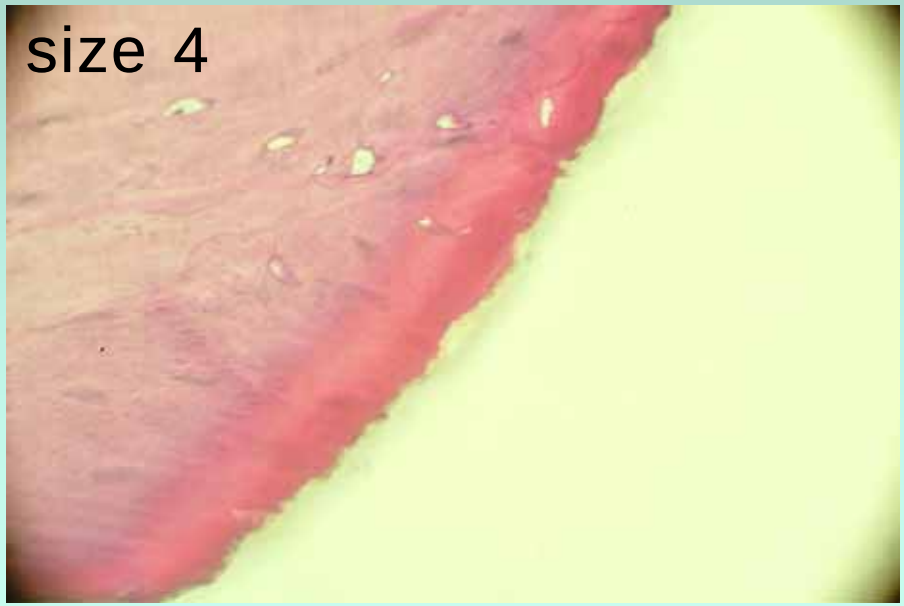


Working Plane 1, size 2,
laser beam movement 1 mm/2 sec

H. Passow



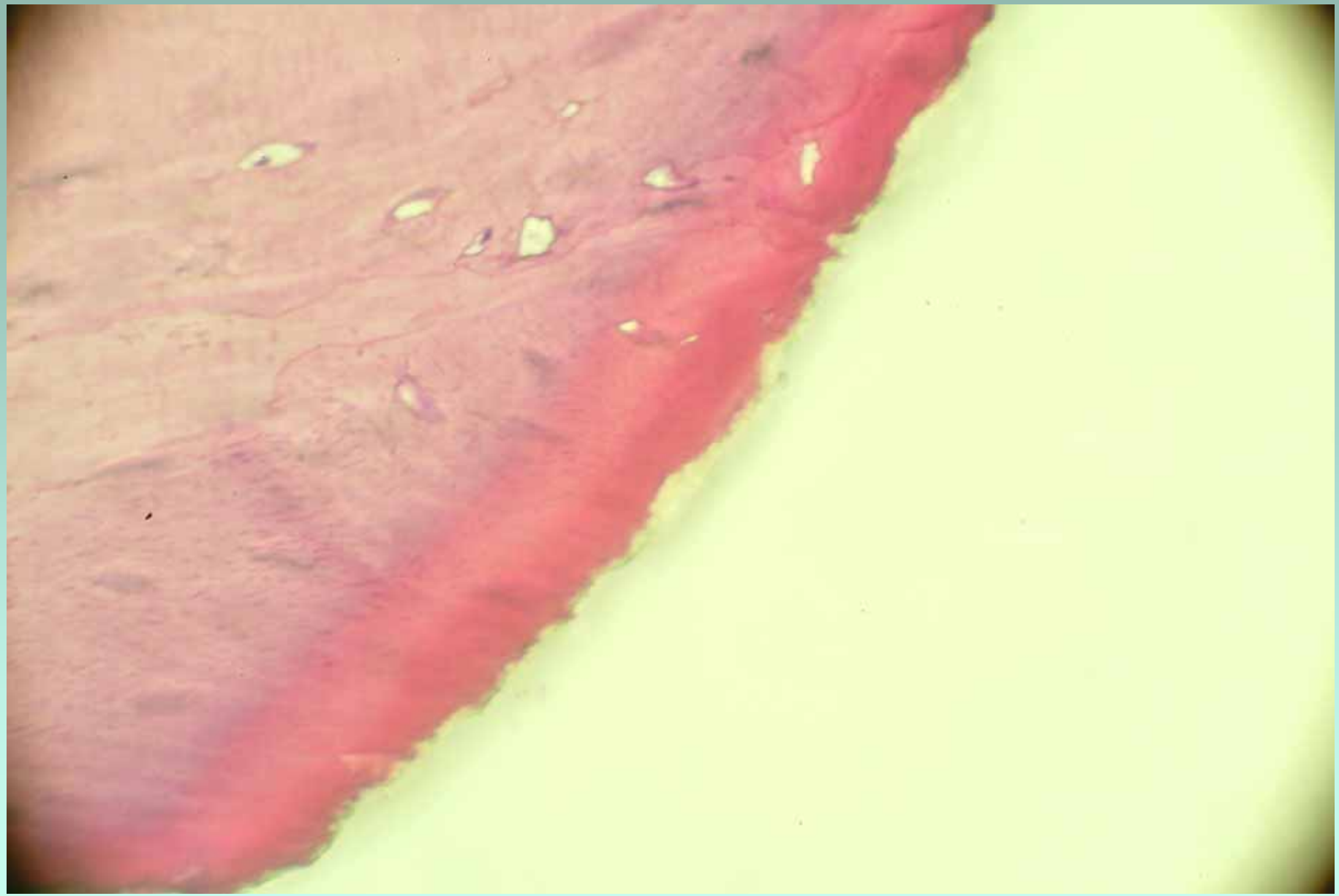




Working Plane 2

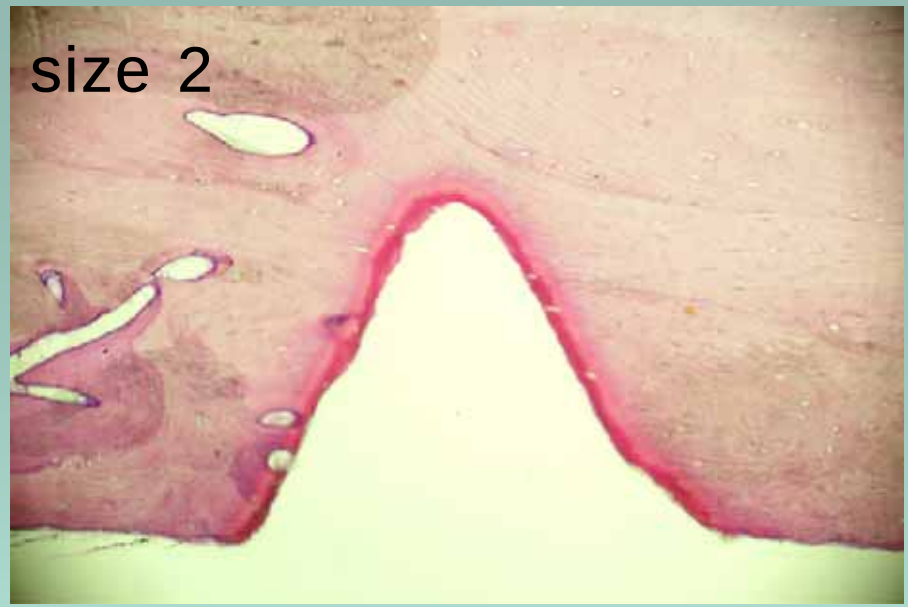
Movement of laser beam was 1 mm in 3 seconds.

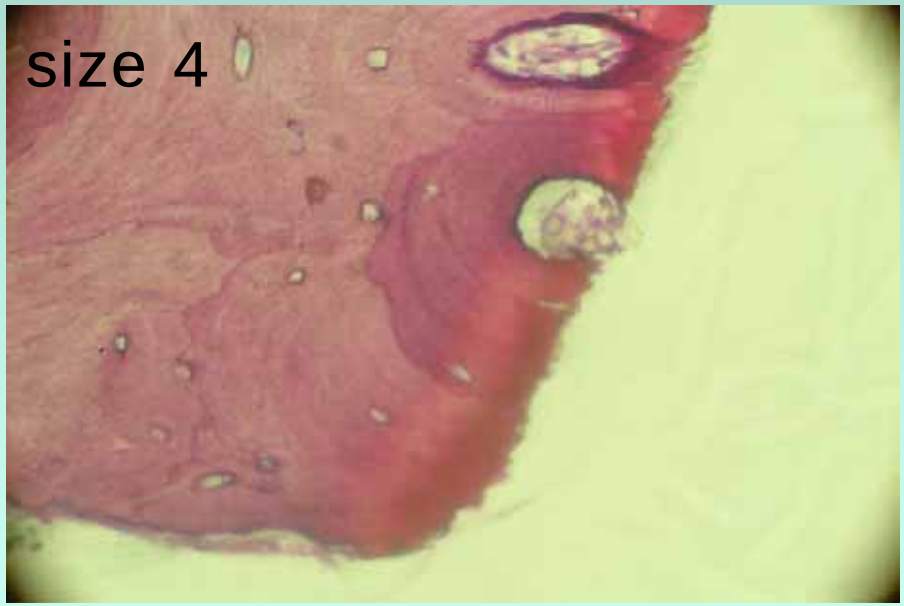
HP



Working Plane 2, size 4
laser beam movement 1 mm/3 sec

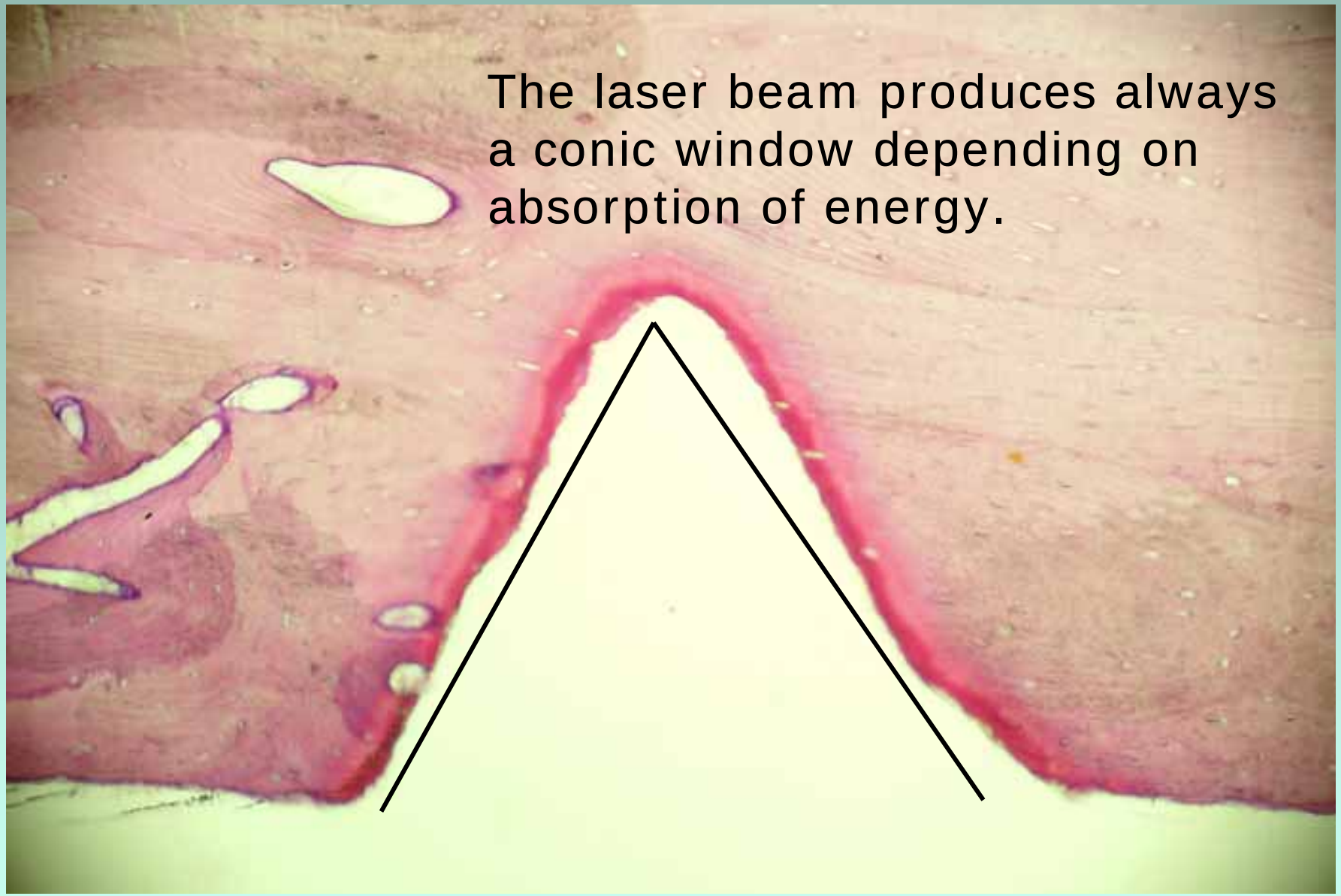
H. Passow





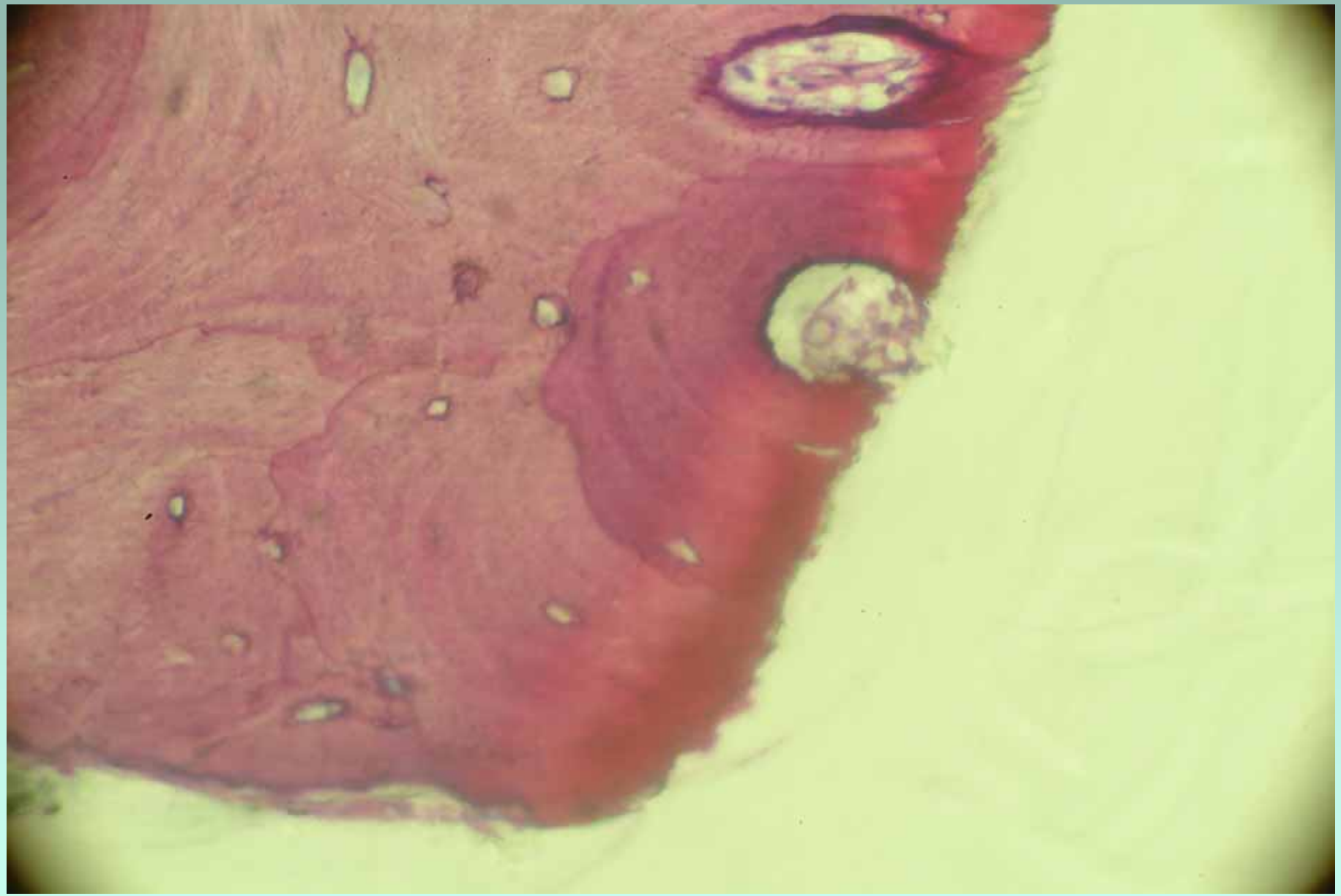
Working Plane 3,
laser beam movement 1 mm/4 sec

H. Passow



Working Plane 3, size 2
laser beam movement 1 mm/4 sec

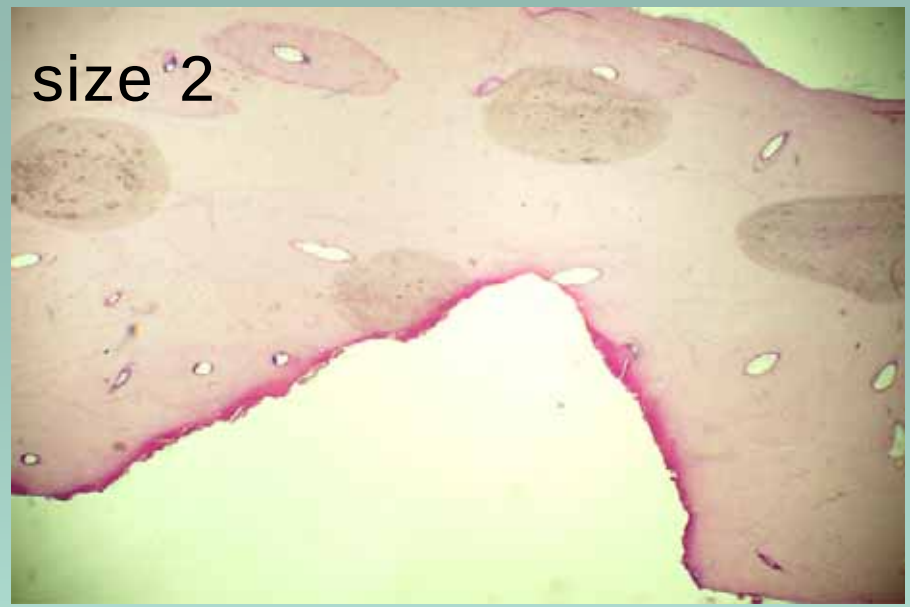
H. Passow

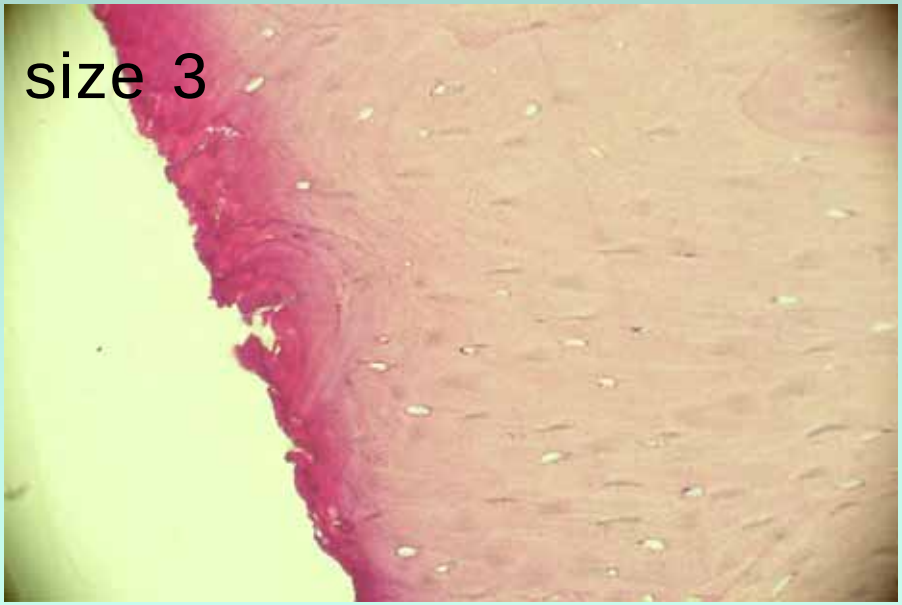


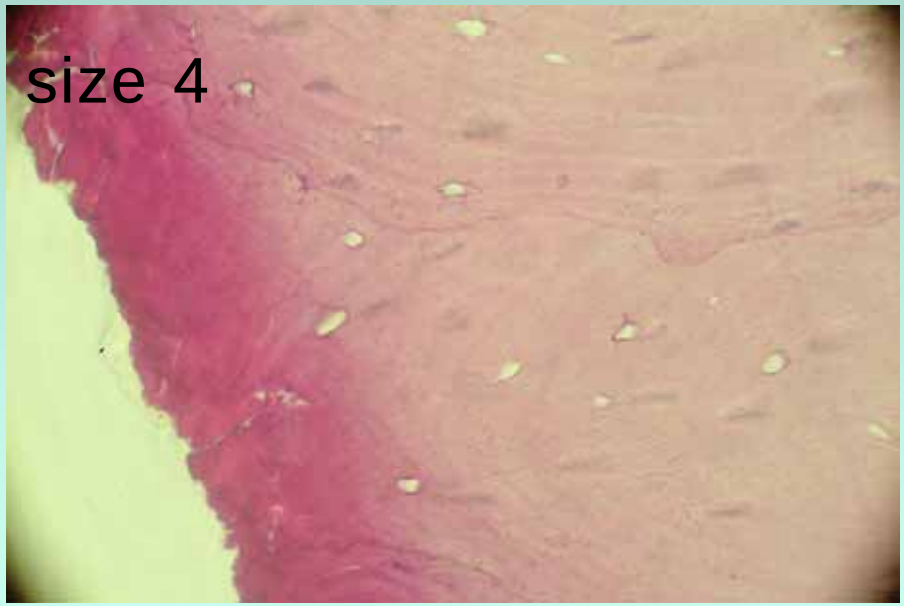
Working Plane 3, size 4
laser beam movement 1 mm/4 sec

H. Passow

Sorry for missing
picture size 1.

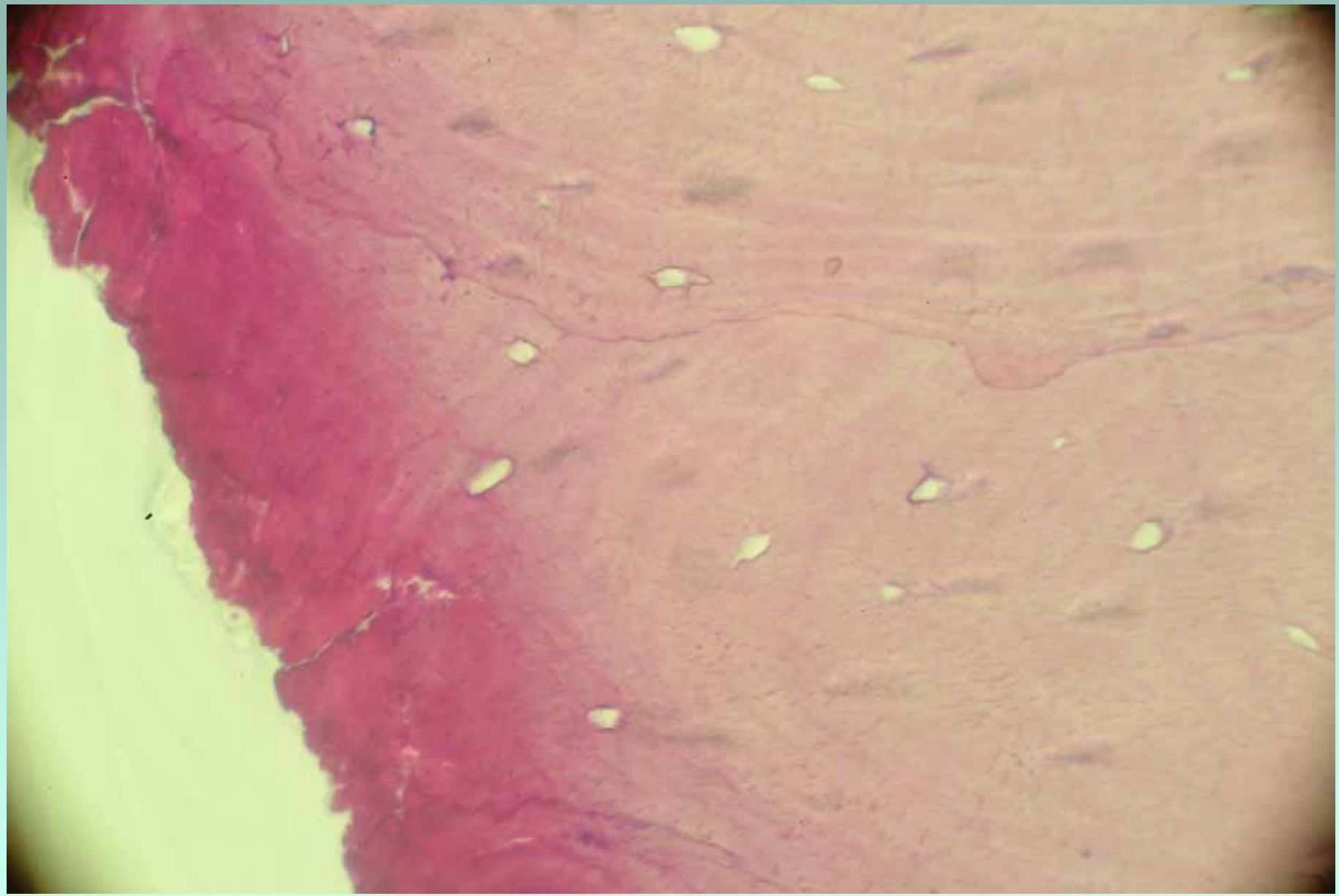






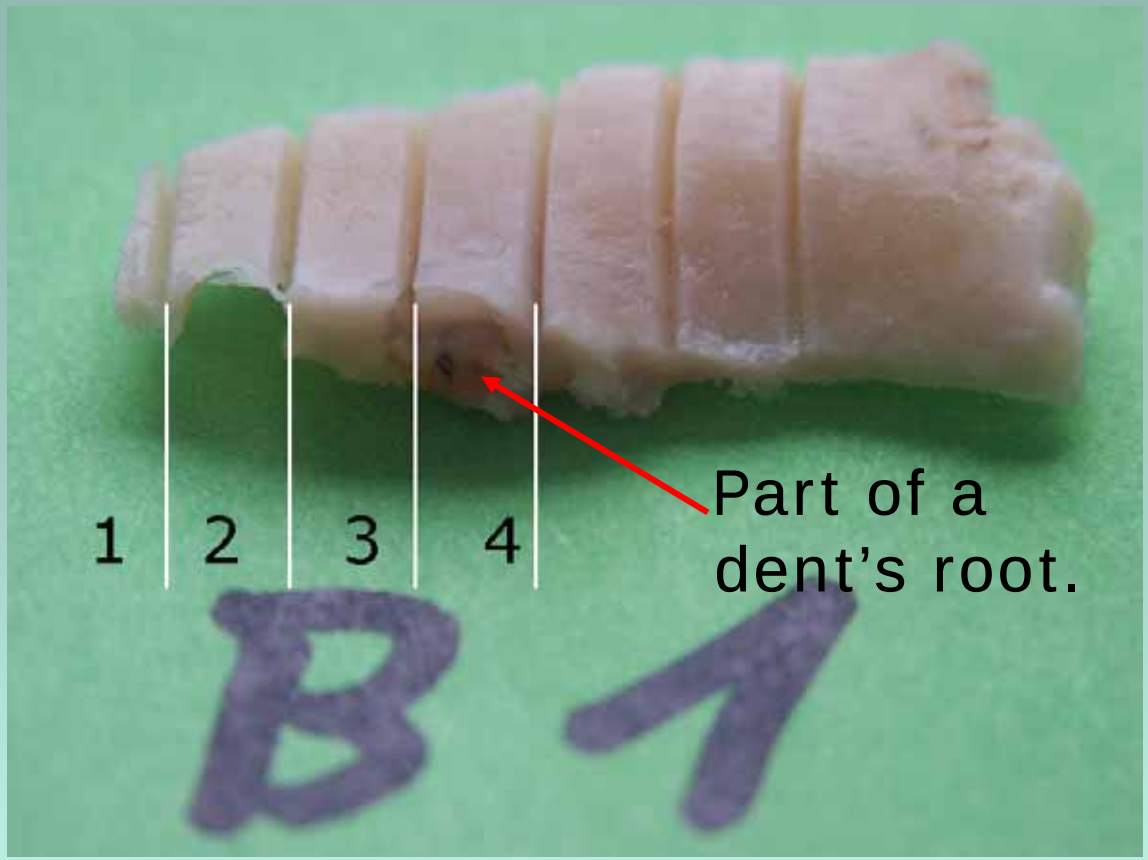
Working Plane 4,
laser beam movement 1 mm/5 sec

H. Passow



Working Plane 4,
laser beam movement 1 mm/5 sec

H. Passow



Distance of the laser work point:
(600 µm Sapphire tip)
3 to 3.5 mm

Laser Settings:
3,5 Watt
Water 65%
Air 65%

Working Plane 1 to 4:
1 = 1 mm/2 sec x 2
2 = 1 mm/3 sec x 2
3 = 1 mm/4 sec x 2
4 = 1 mm/5 sec x 2

Angle of the laser point to the preparation 25°

x 2 = The laser beam run each line twice (done to show the exact operation of the unit).

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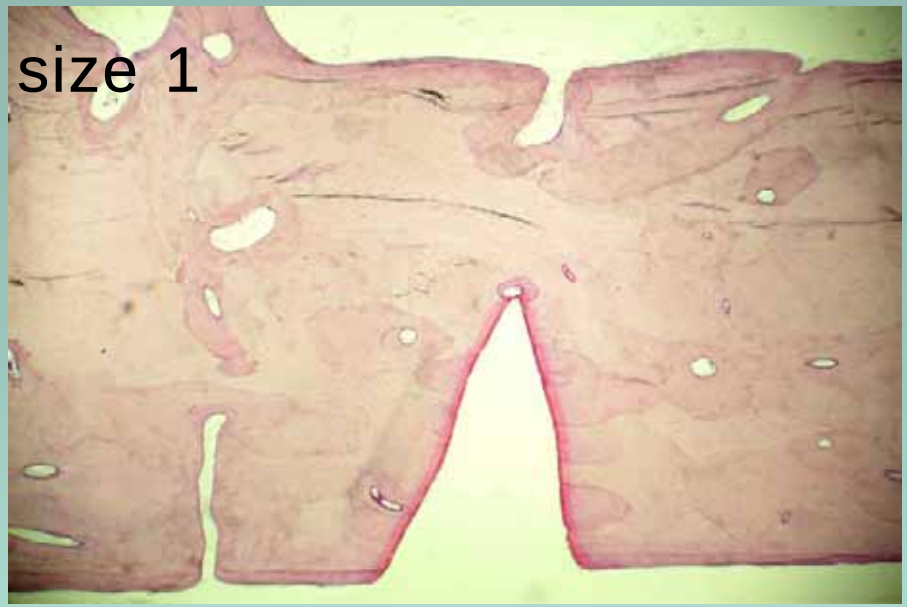
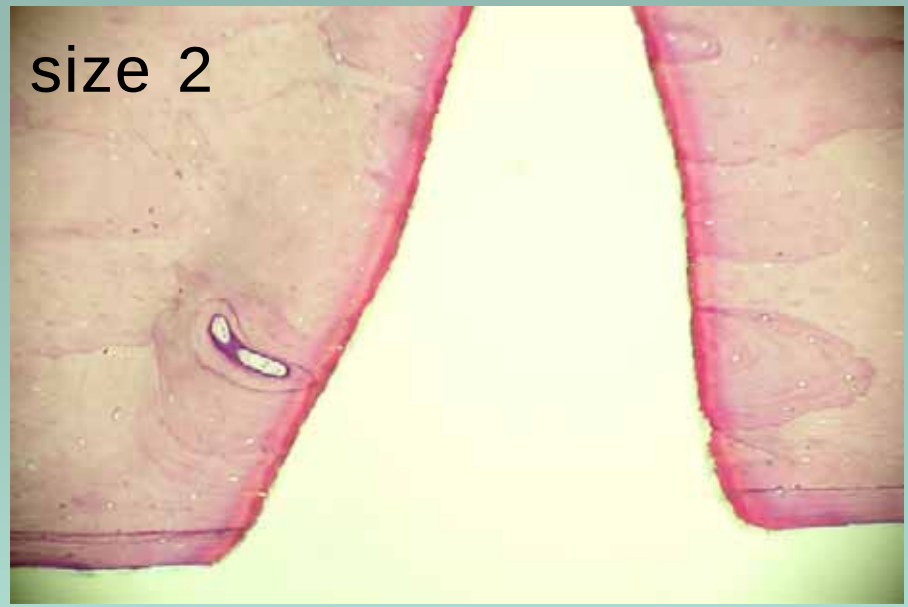
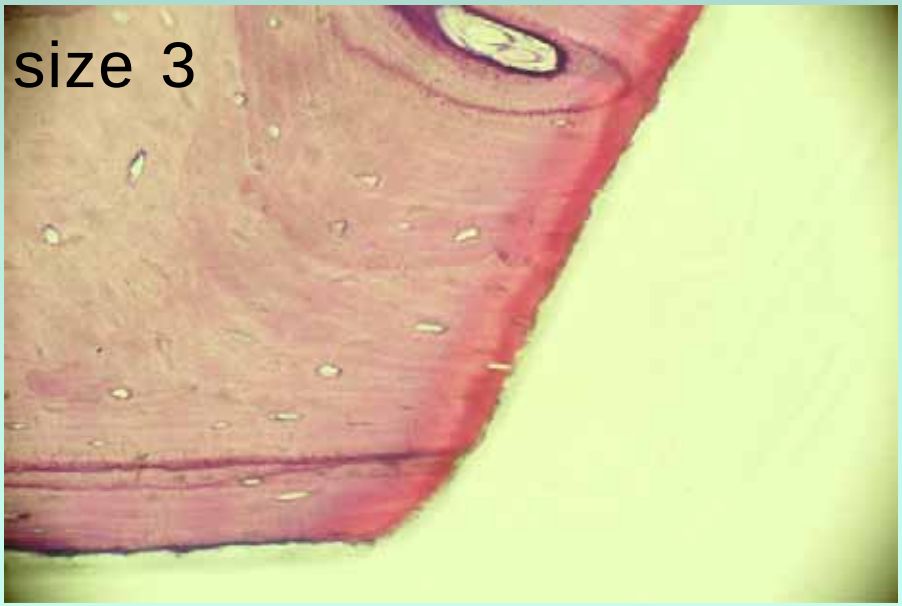
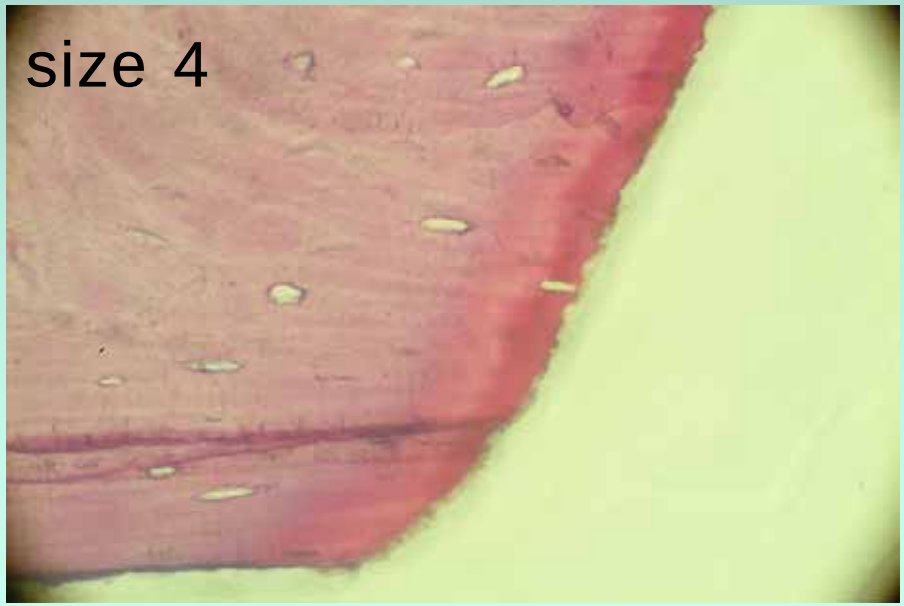


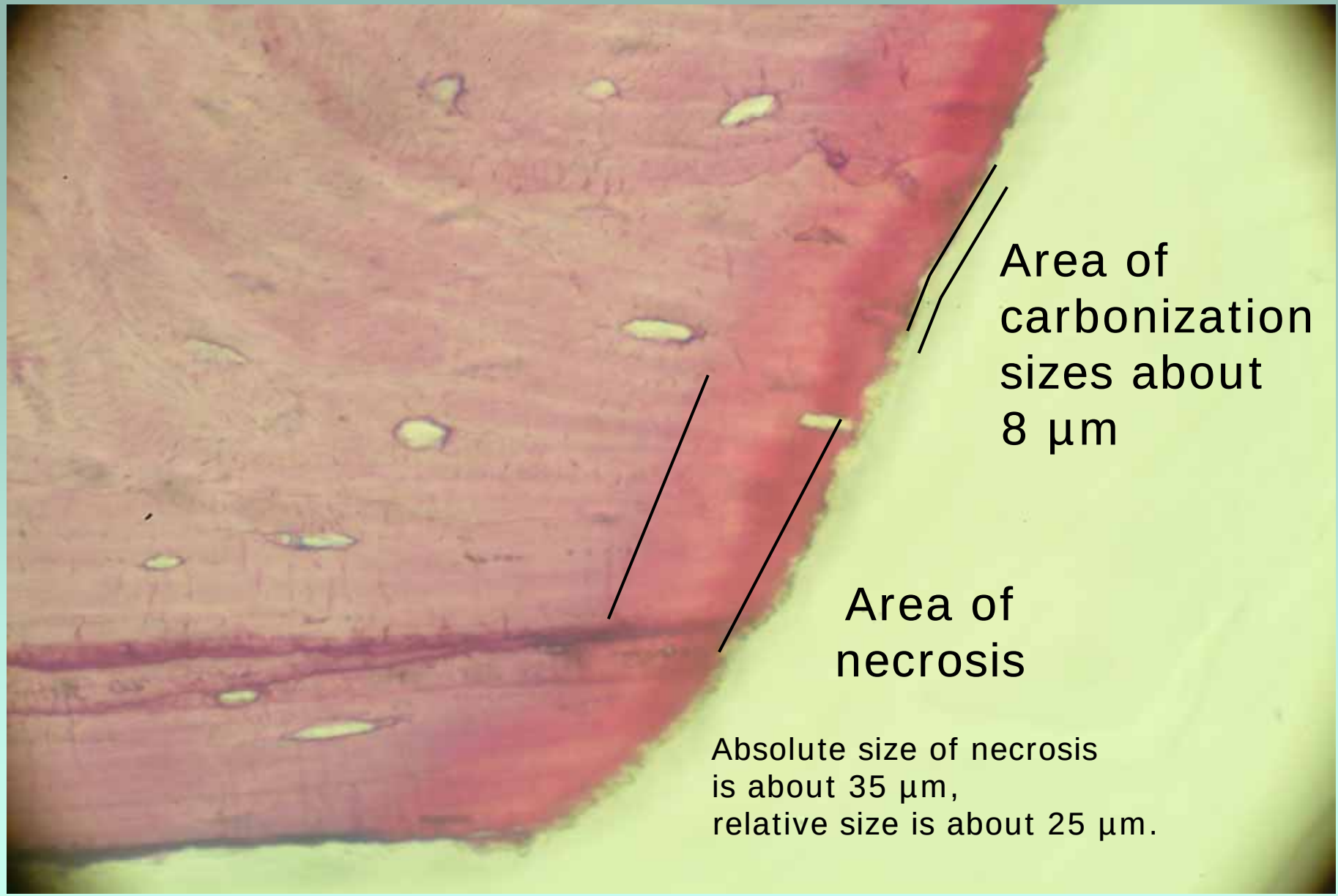






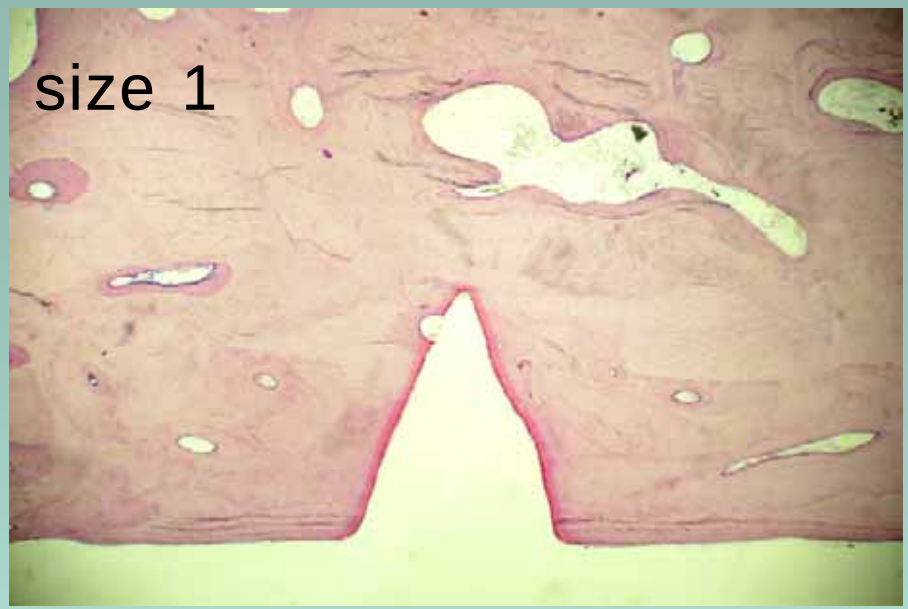
Working Plane 1,
laser beam movement 1 mm/2 sec x 2

H. Passow



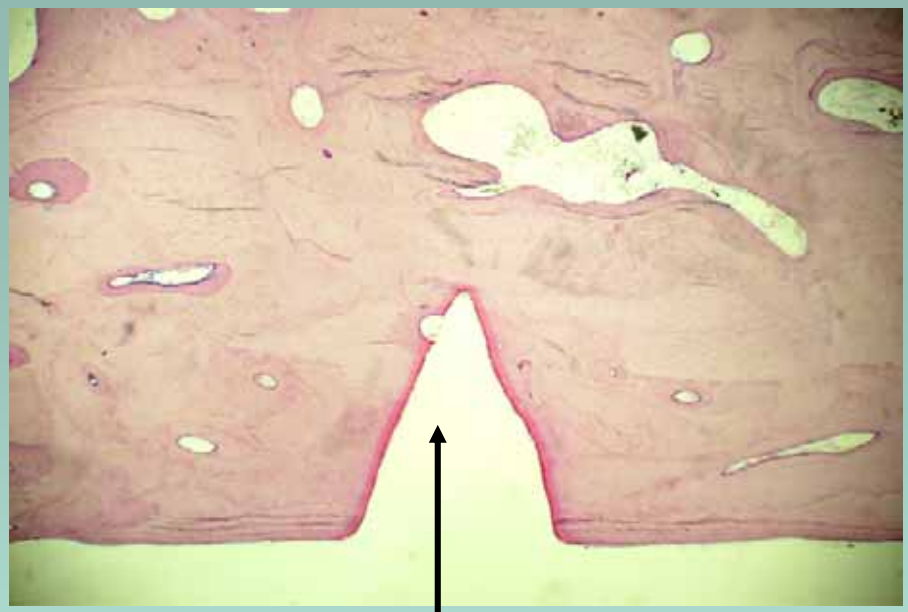
Working Plane 1, size 4
laser beam movement 1 mm/2 sec x 2

H. Passow



Working Plane 2,
laser beam movement 1 mm/3 sec x 2

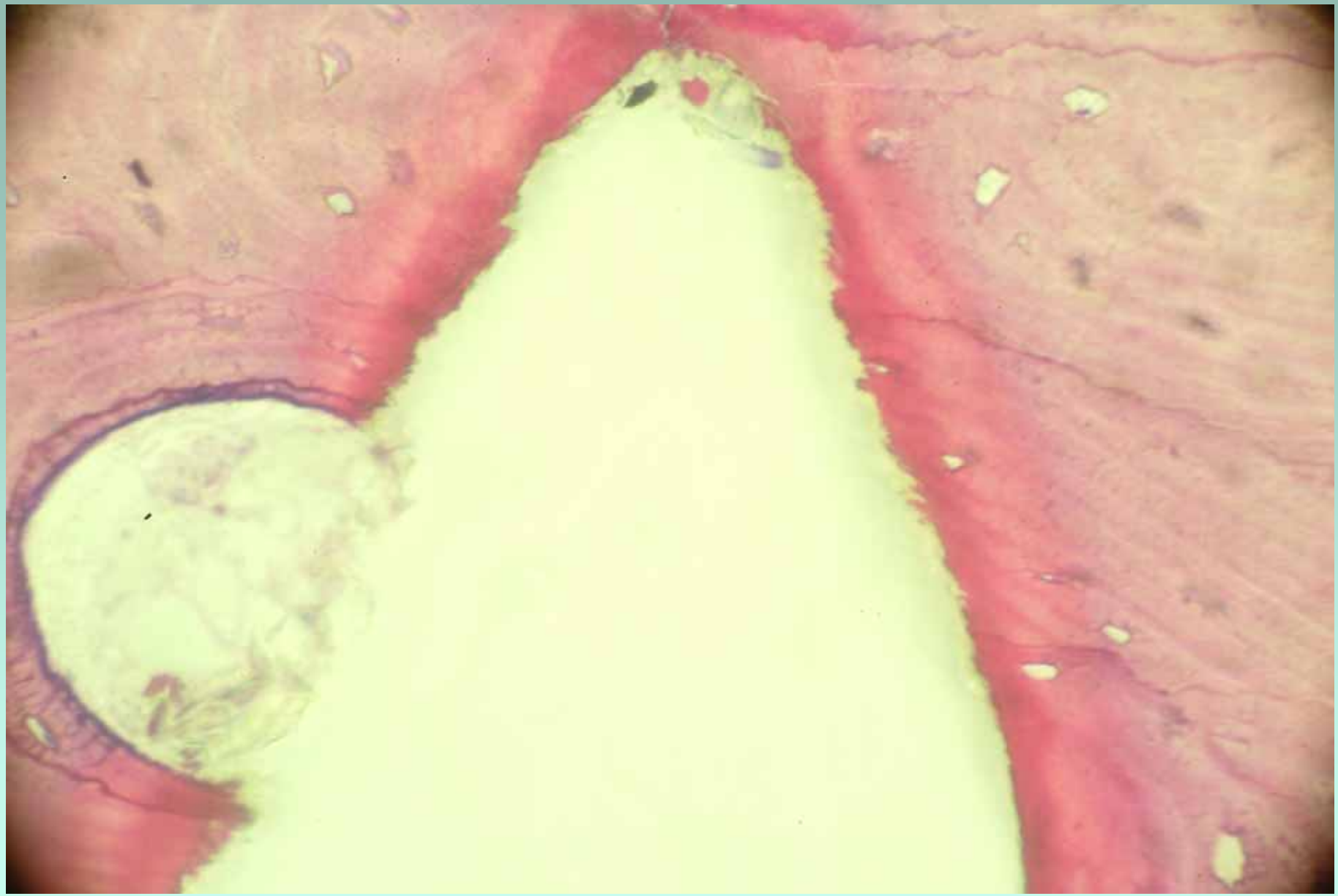
H. Passow



The laser beam always produces
a conic window,
but during this arrangement the
cone is longer and pointed.

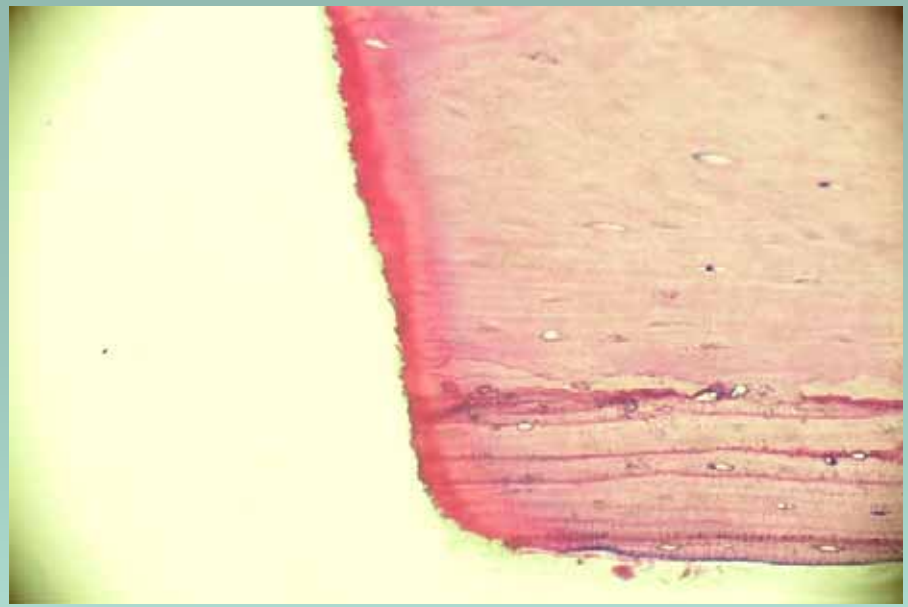
Working Plane 2, size 1
laser beam movement 1 mm/3 sec x 2

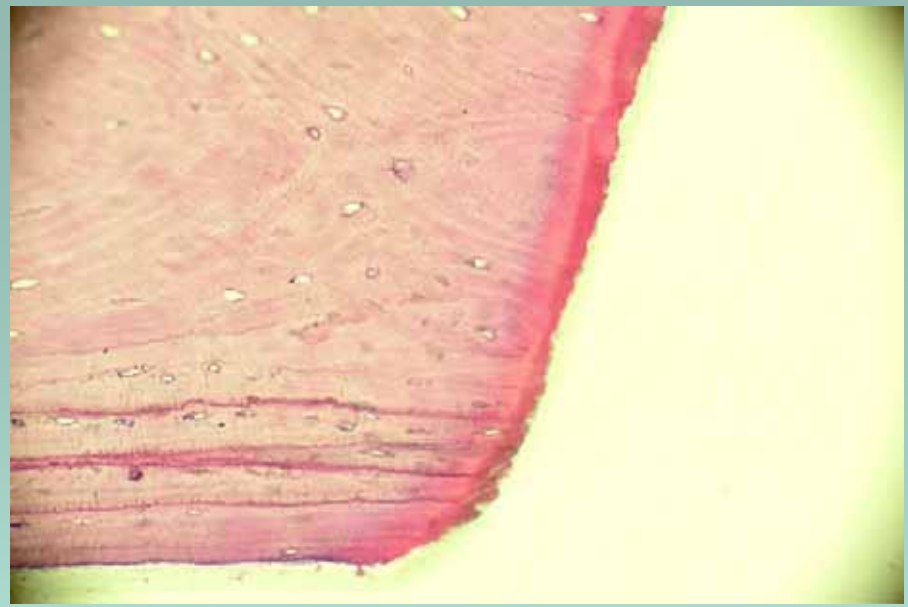
H. Passow



Working Plane 2, size 3
laser beam movement 1 mm/3 sec x 2

H. Passow

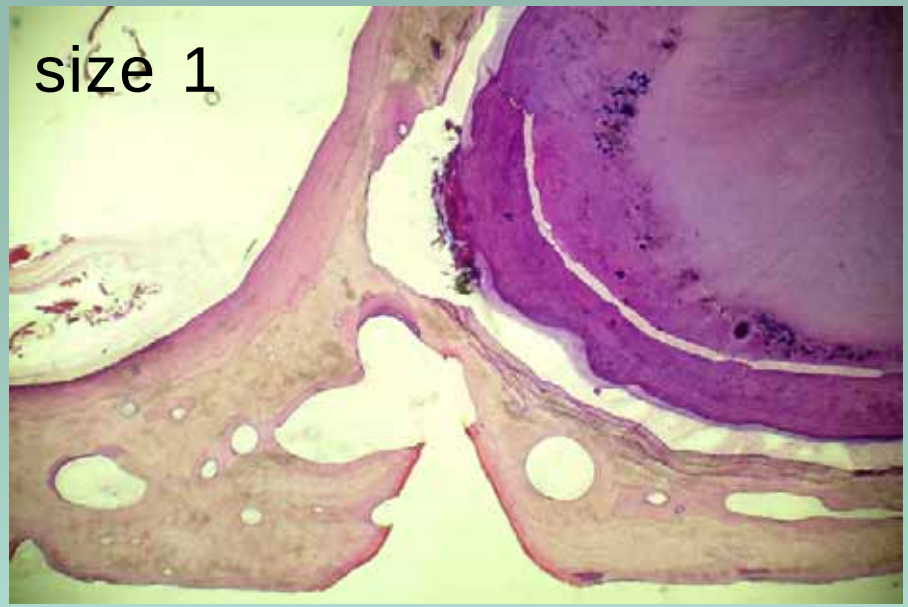


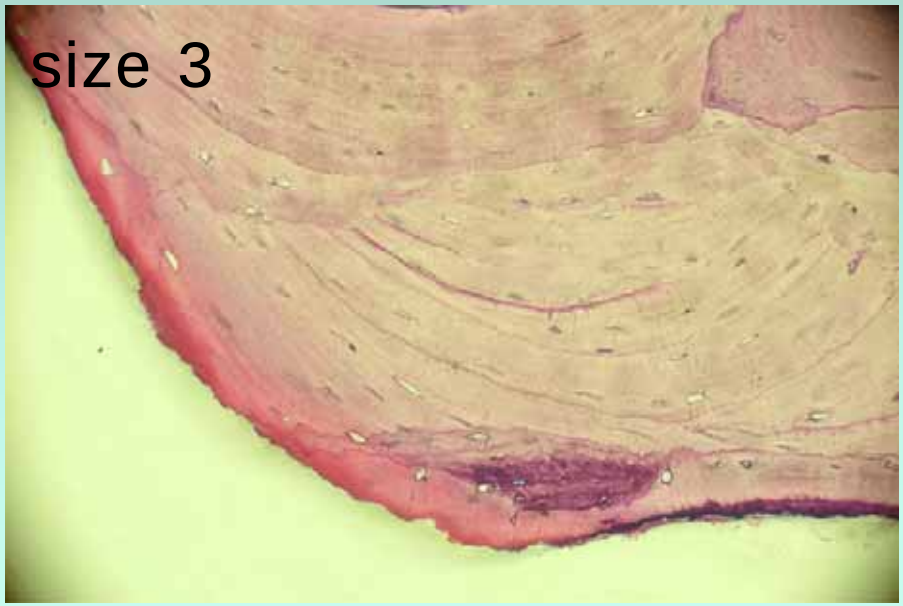


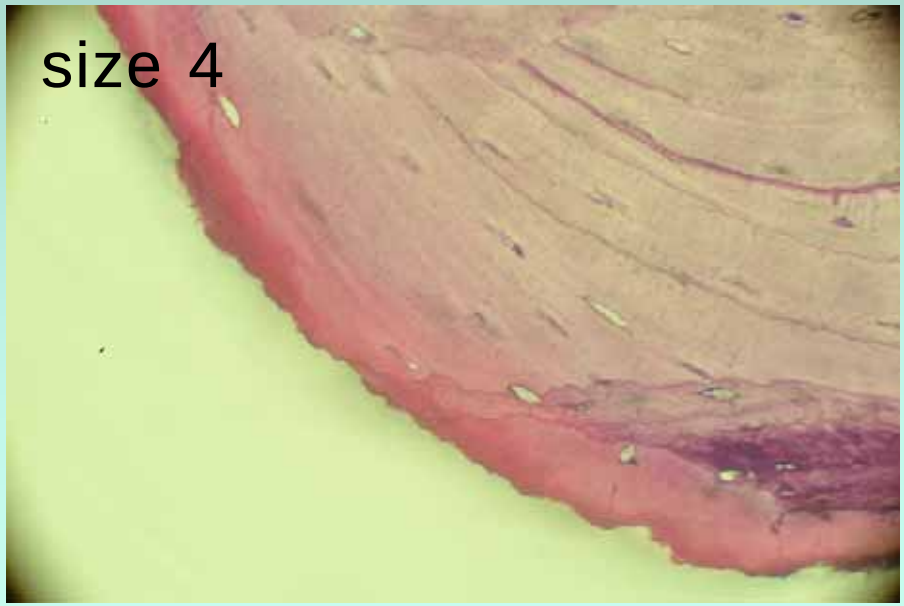
Higher magnification
from size 1

Working Plane 2,
laser beam movement 1 mm/3 sec x 2

H. Passow







Working Plane 3,
laser beam movement 1 mm/4 sec x 2

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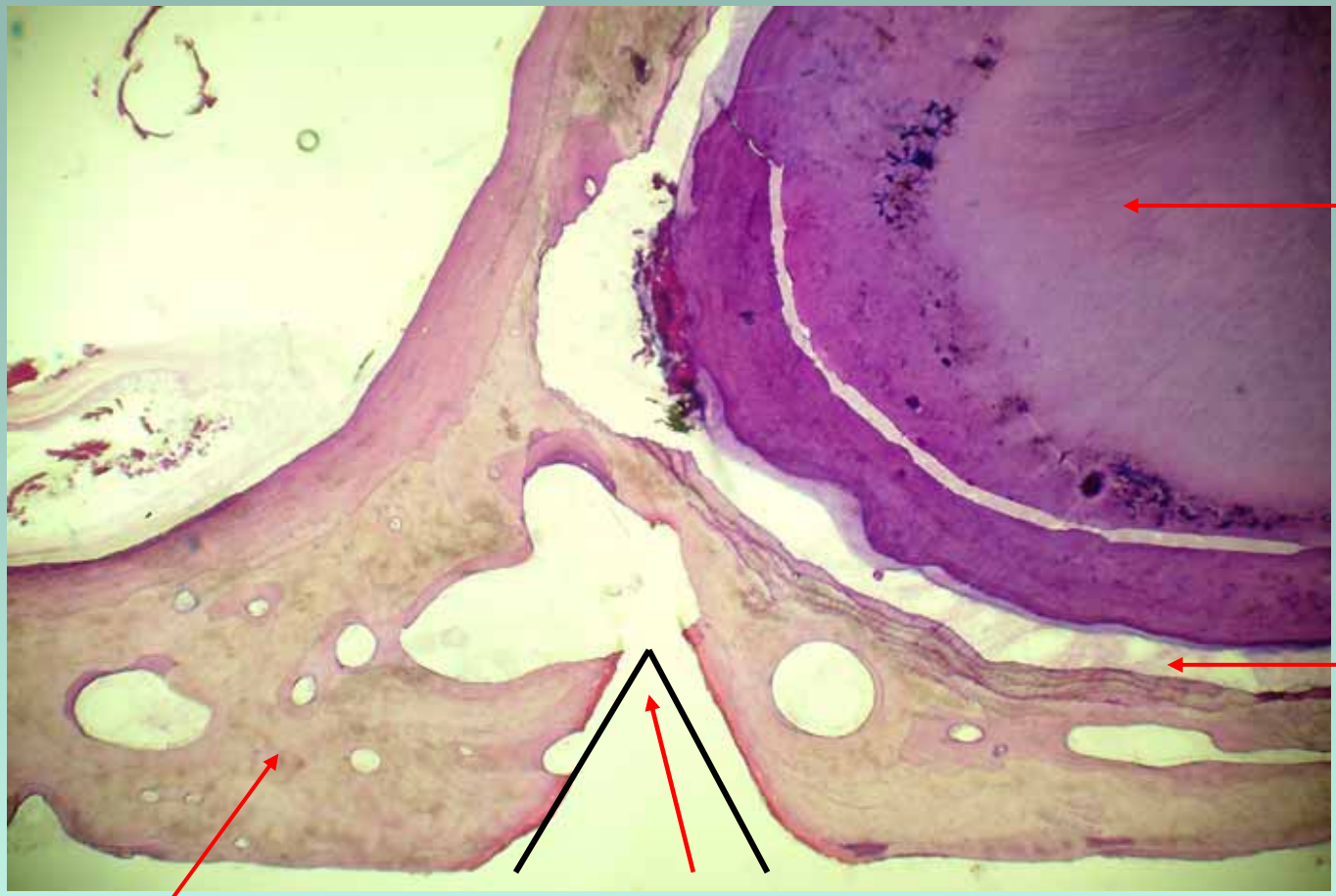
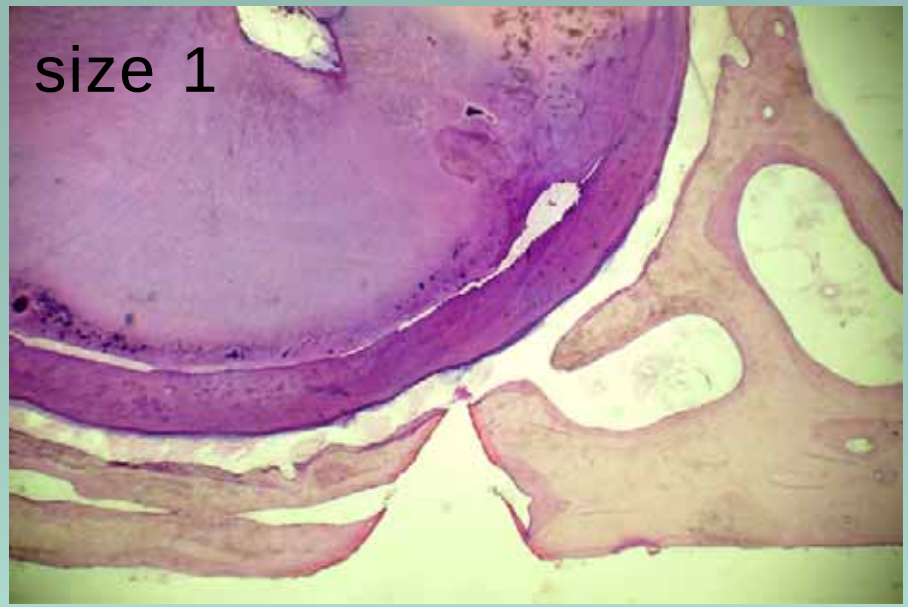
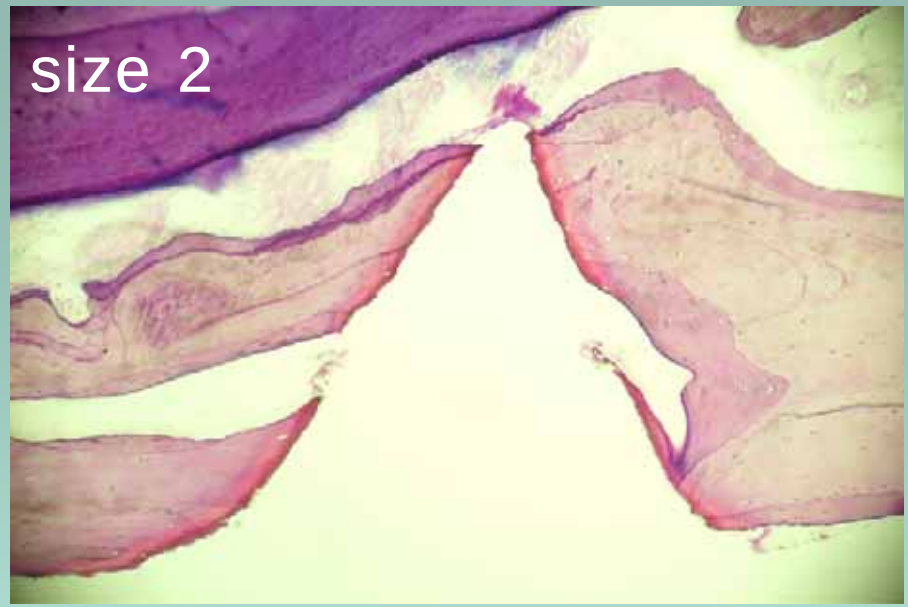
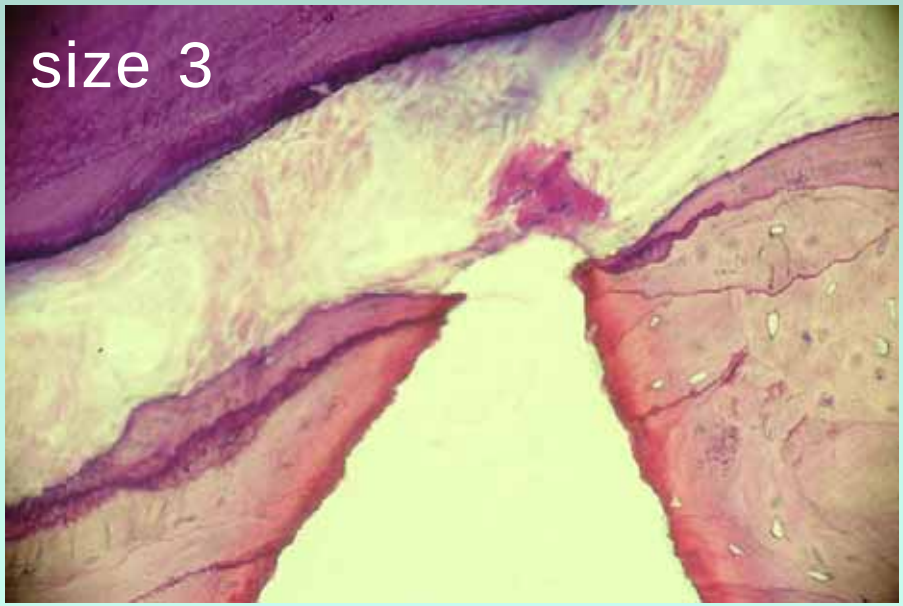


Working Plane 3, size 1
laser beam movement 1 mm/4 sec x 2

H. Passow

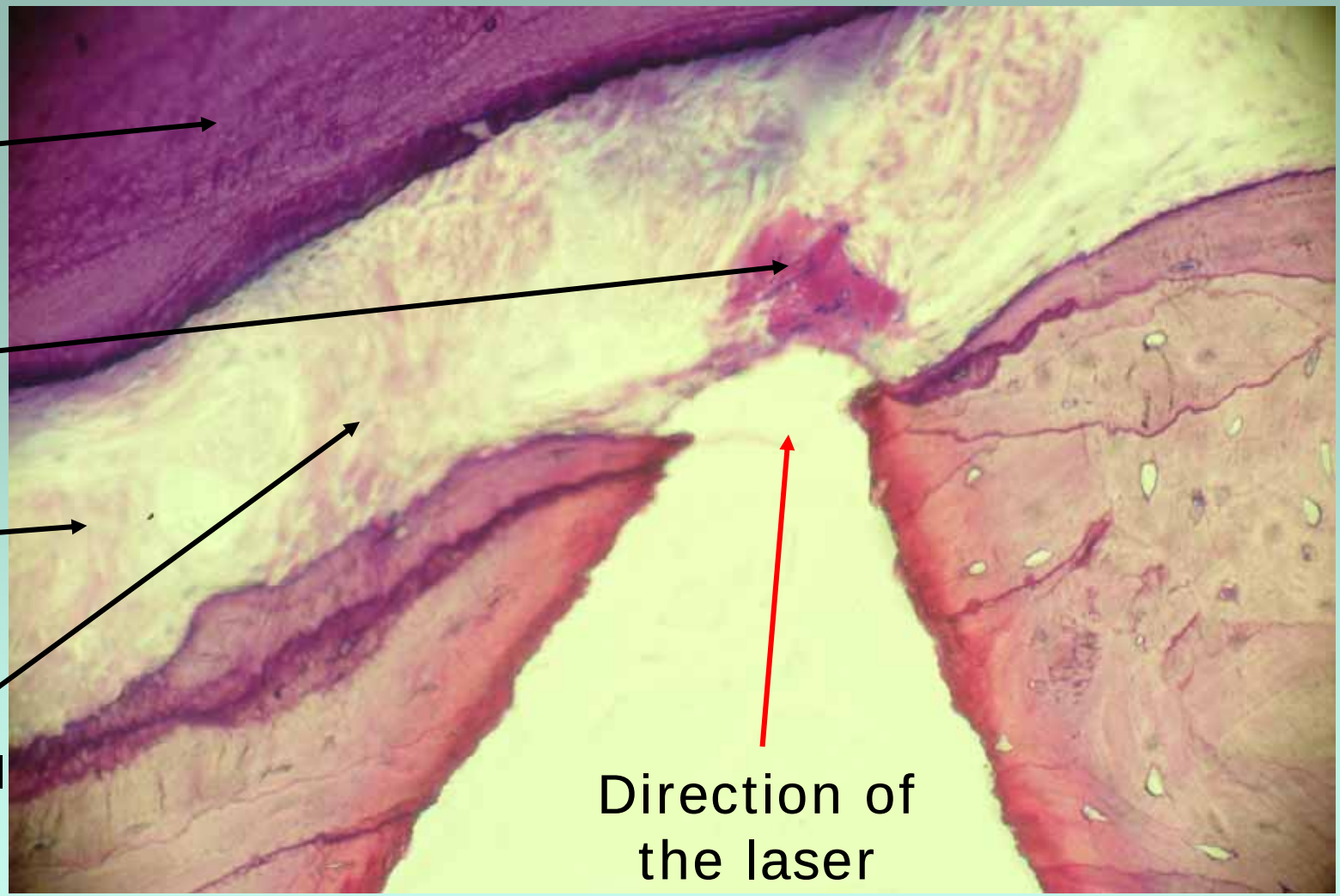






Working Plane 4, higher enlargement
laser beam movement 1 mm/5 sec x 2

H. Passow



Working Plane 4, size 3
laser beam movement 1 mm/5 sec x 2

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Summary of the Histological Results

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The laser causes a wedge shaped cutting form in the bone.

The definite zone of the carbonization amounts to approx. 5 to 15 µm.

The zone of the further histological tissue effect amounts to approx. 80 µm, whereby no destruction of the anatomical structure is recognized.

What is most important with this laser is the perfect cooling spray from water and air, which is only achieved by this laser.

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Lasers are not a new toy in dentistry,
Erbium lasers are the future of dental medicine and will replace the drill for many common dental procedures.

Or do you think that dentists will still work with drills to excavate caries in teeth in the future?
Think about eye lasering.

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So, now you have seen that there is
no problem to work with the YSGG-Laser
on human bones, too.

You will not harm your patients
in your dental office.

Go on and work with that Laser!

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Thank You
for Your
Attention.

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