

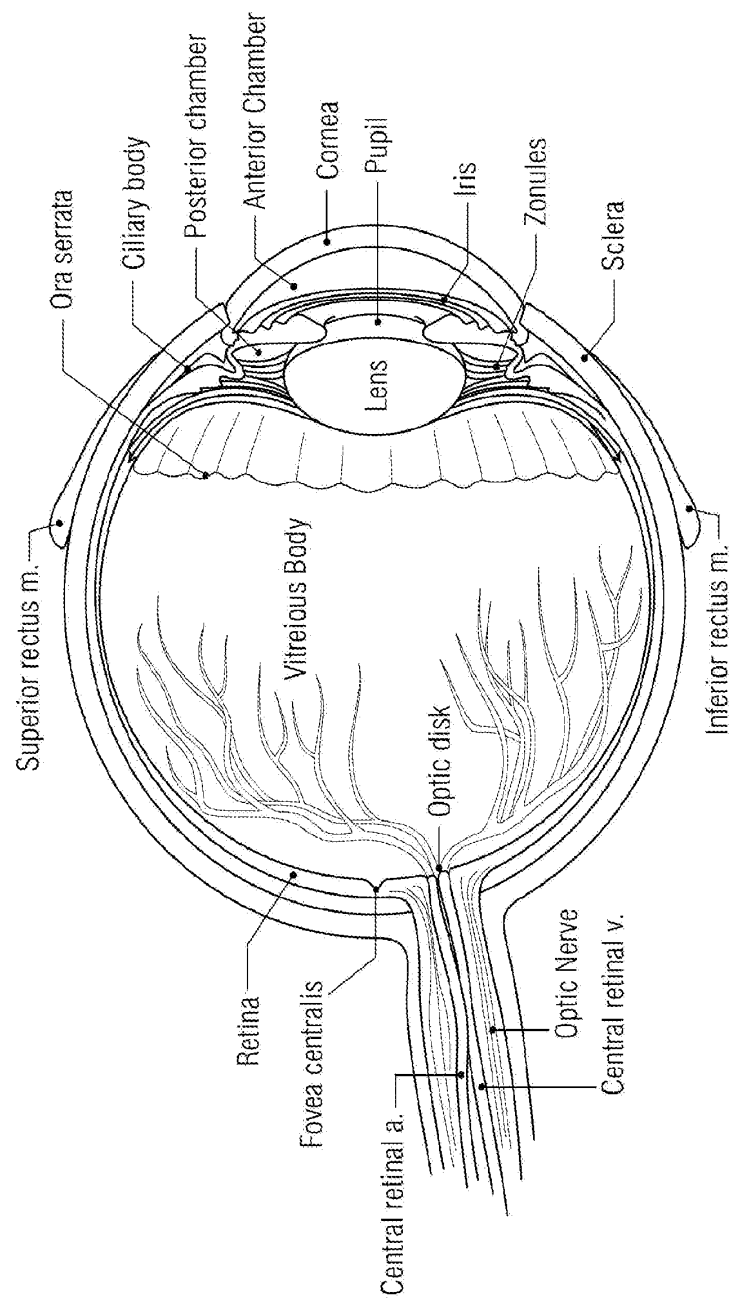


Fig. 1 : Ocular Anatomy

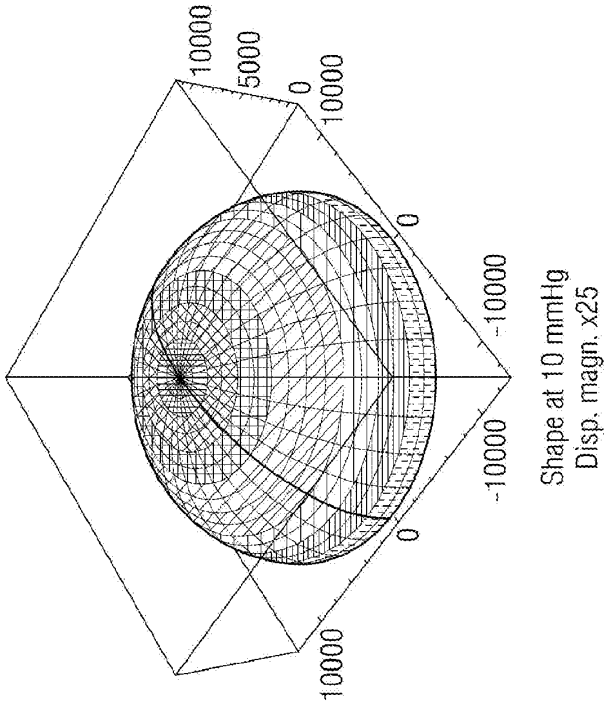


Fig. 2B

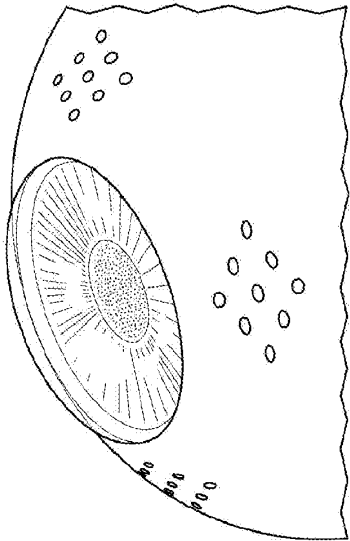


Fig. 2A

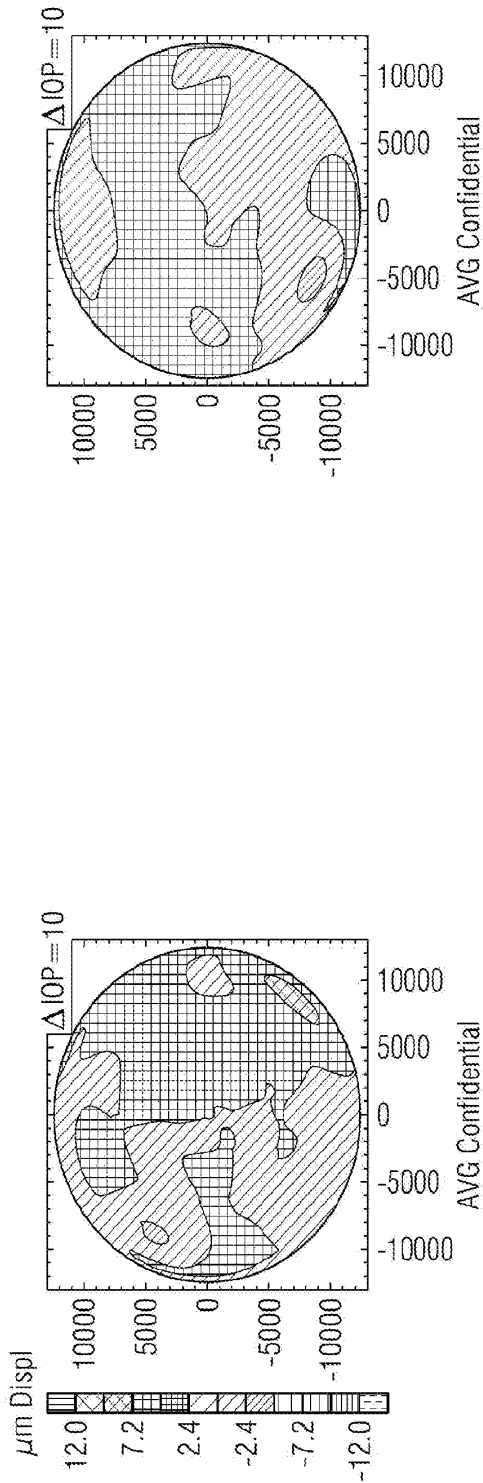


Fig. 2D

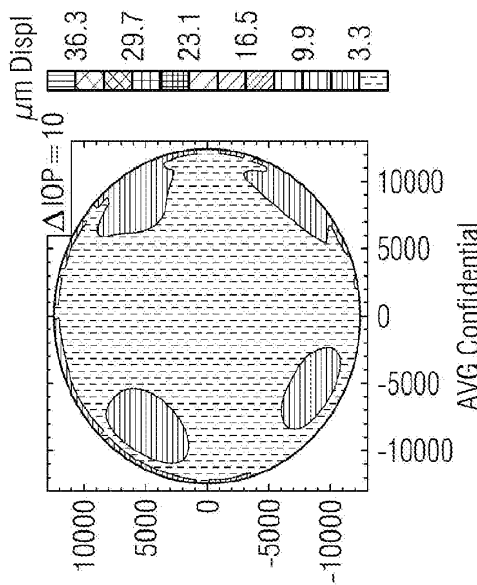


Fig. 2E

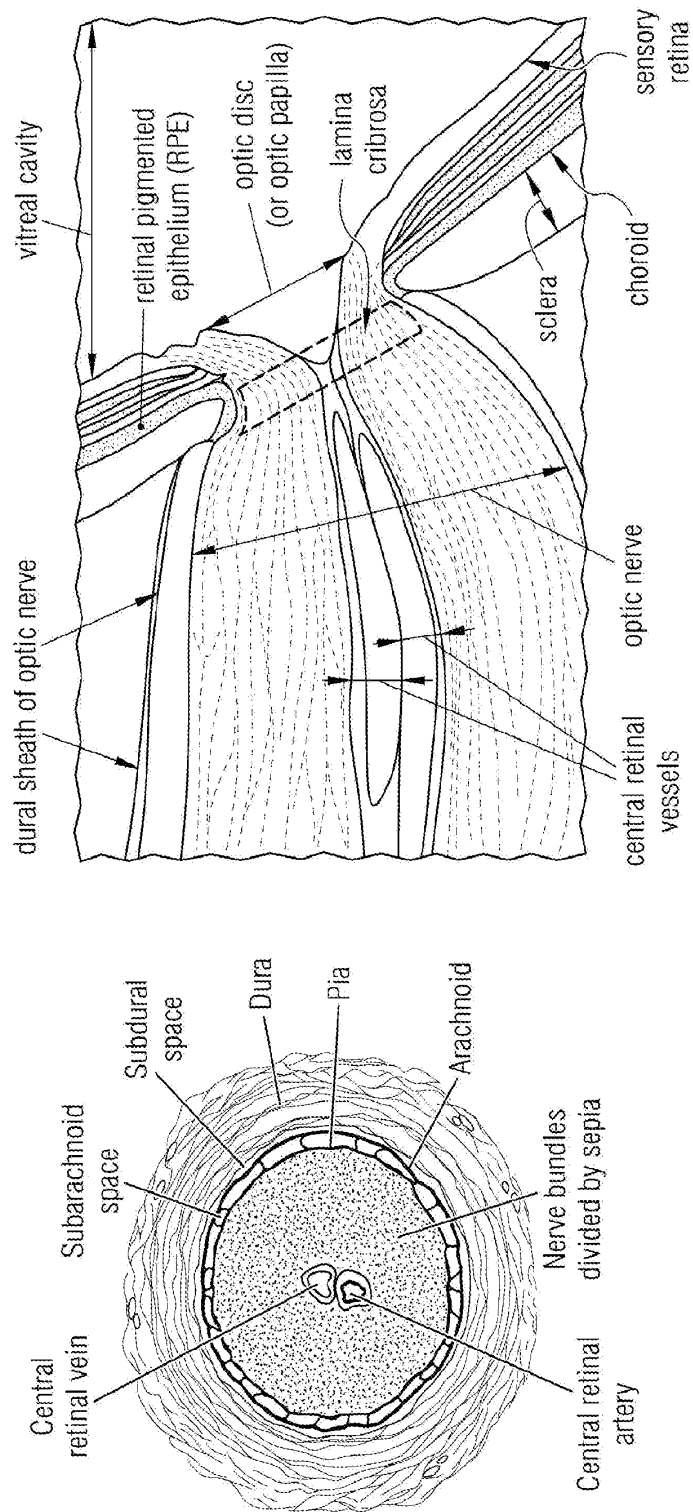


Fig. 3: Optic Nerve and Optic Disc

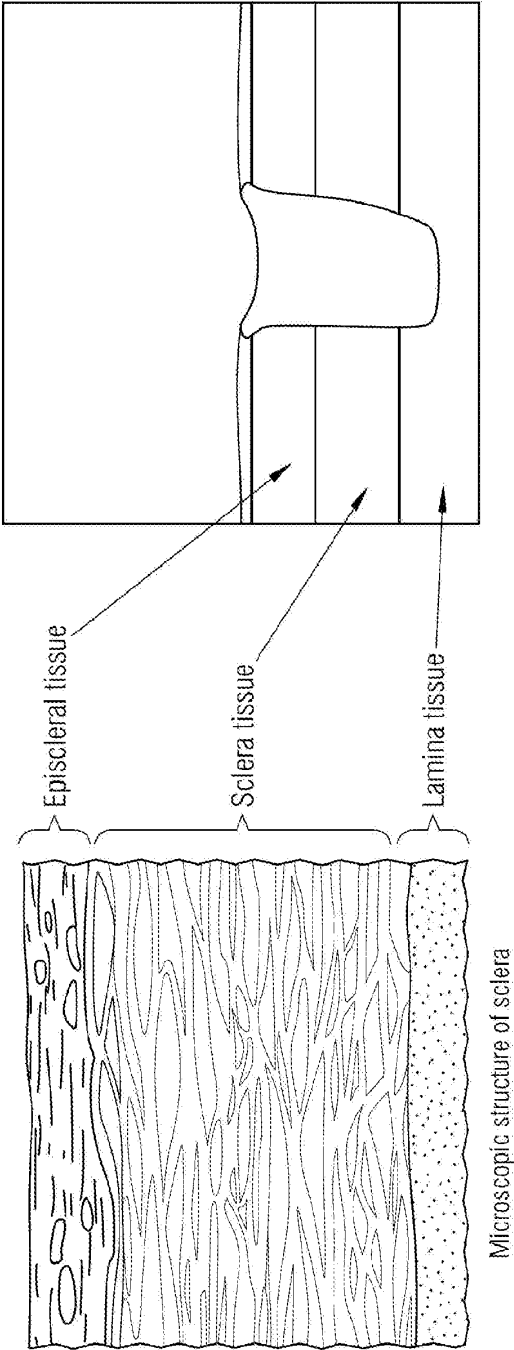
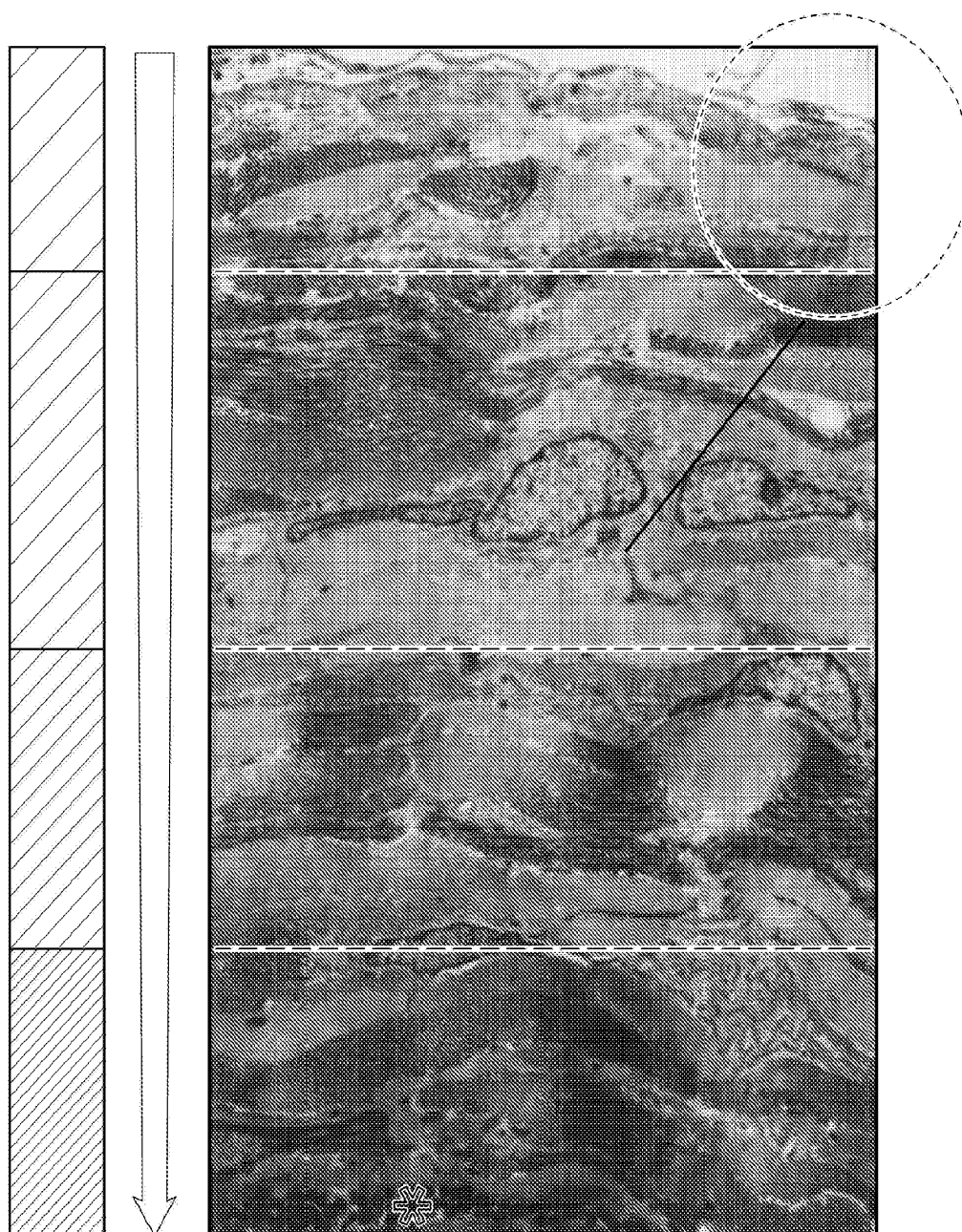


Fig. 4: Micropore & the Sclera

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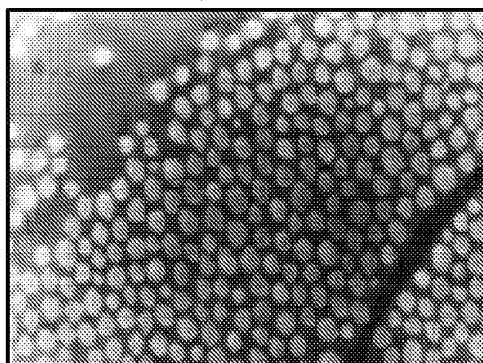
Transverse section through sclera. The lamellae forming the bulk of the sclera are denser and more irregular in outline than in the cornea. Episclera is less dense than the deeper scleral layers. The lamina fusca portion of the sclera contains some pigment (asterisk) that migrated from uvea. Sclerocytes (like keratocytes), which are swollen in the micrograph, are not as numerous as in the cornea. Rat; X 4,000

Fig. 5A: Sclera Ultrastructuree: Scleral Subsurface
3D Pore Creation approx. 400 μ m diameter

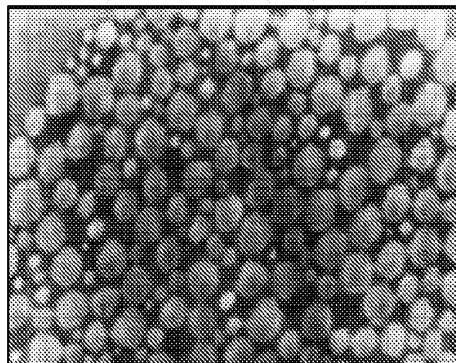
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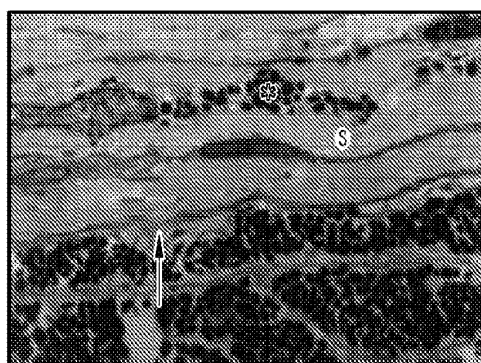
EpiSclera



High magnification of collagen fibers in the episclera. Collagen fibers, here section transversely, are of a relatively uniform diameter albeit not as uniform as found in the corneal stroma. Some elastin is present among the collagen. Rabbit.

Sclera Stroma
(Substantia propria)

High magnification of collagen fibers in the scleral substantia propria. The transversely sectioned collagen fibers from this scleral region show distinctly greater variation in caliber when compared to those in the episclera. Elastin is noticeable also in this part of the sclera. Rabbit.



Lamina fusca

Transverse section through the scleral-choroidal interface. The lamina fusca of the sclera consists of lamellae of collagen fibers (S), sclerocytes and melanocytes (asterisk). The suprachoroid is formed of fibrocyte processes (arrow) organized in a parallel manner and melanocytes (triangle). Primate: X 5,000

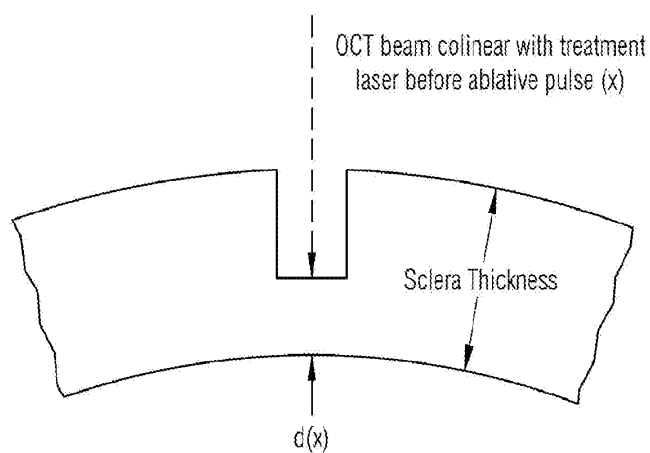


Choroid

FIG. 5B

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Pulse energy for the next pulse (x+1) has an expected micropore depth. If readings after the pulse do not increase as expected an out of range result can be communicated to the system controller. $d(x+1) \geq d(x)$

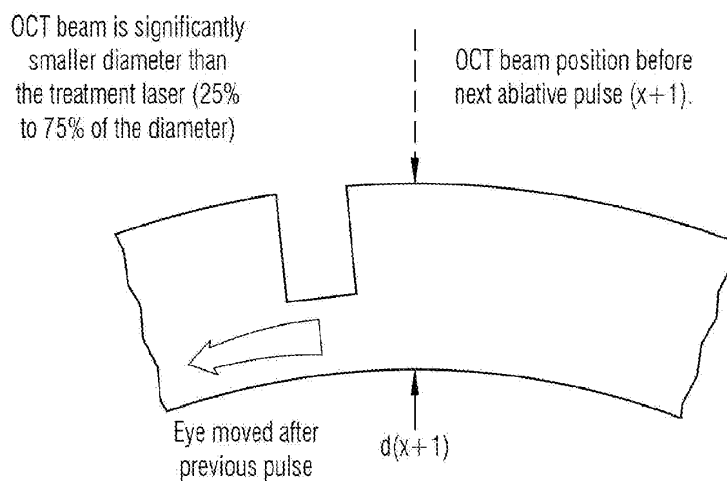


Fig. 6: Depth method to monitor eye motion between pulses of ablation

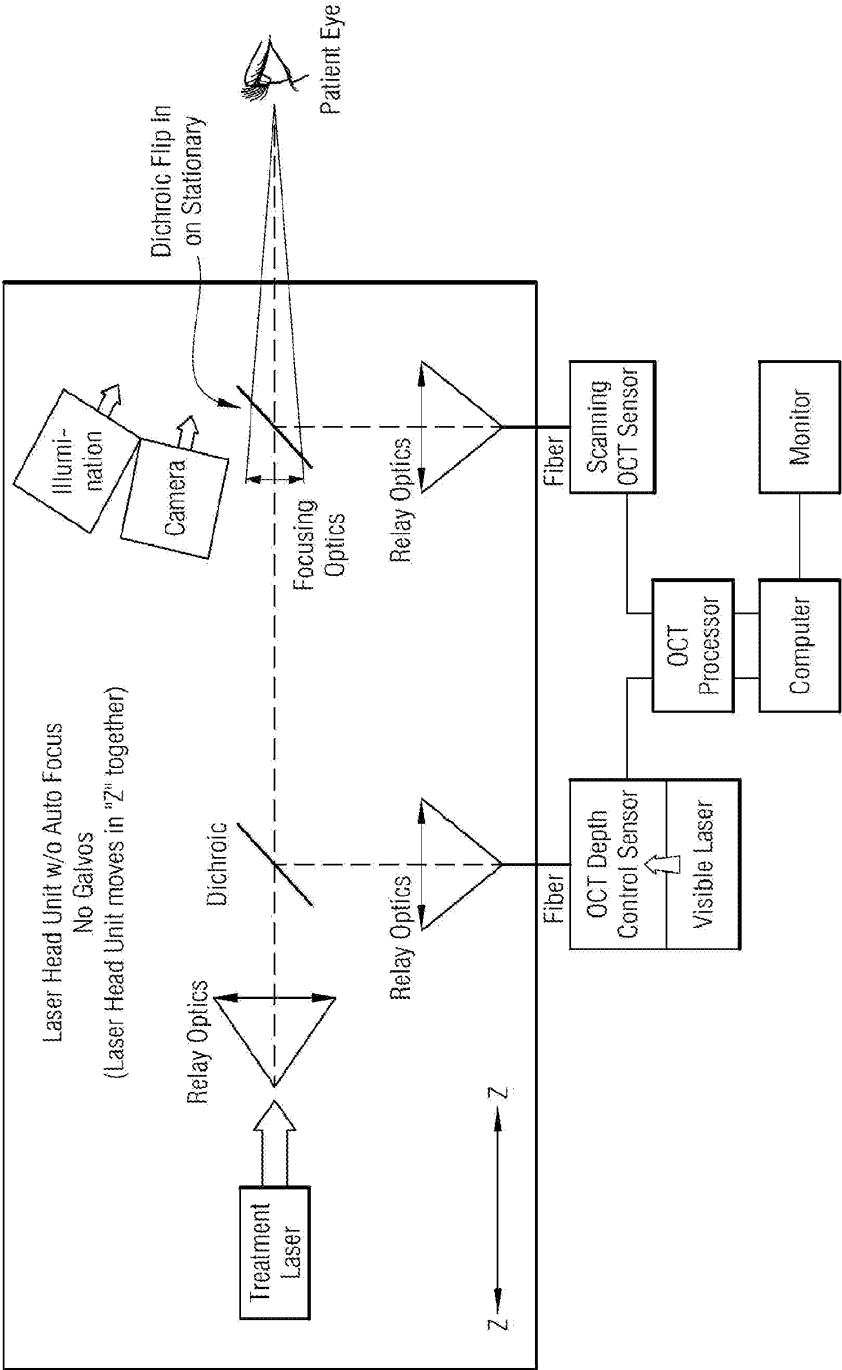


Fig. 7: System with no galvo, 5 axis Head and separate Z motion

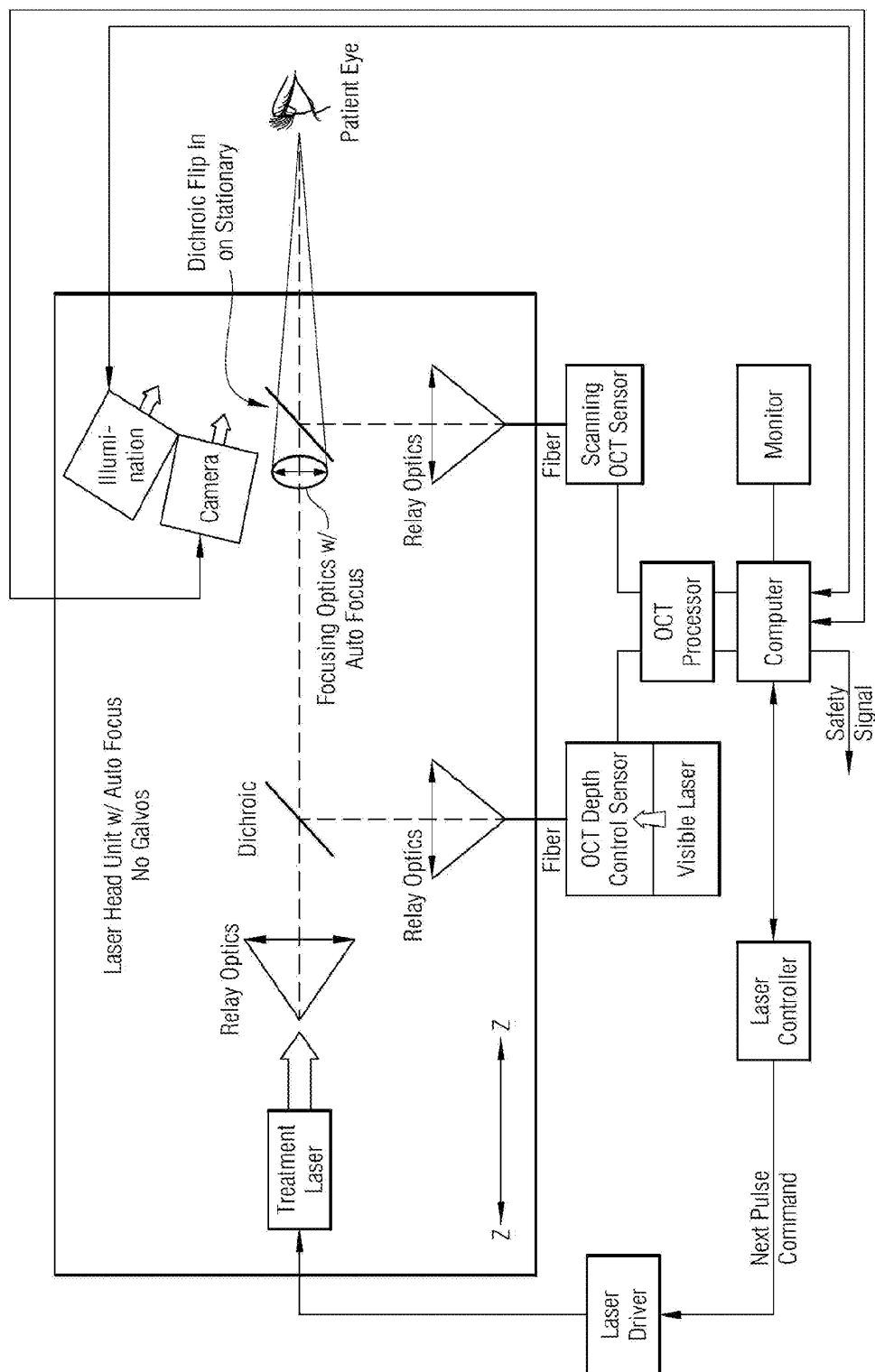


Fig. 8: Control of Laser Head with no galvo, 5 axis Head and separate Z motion

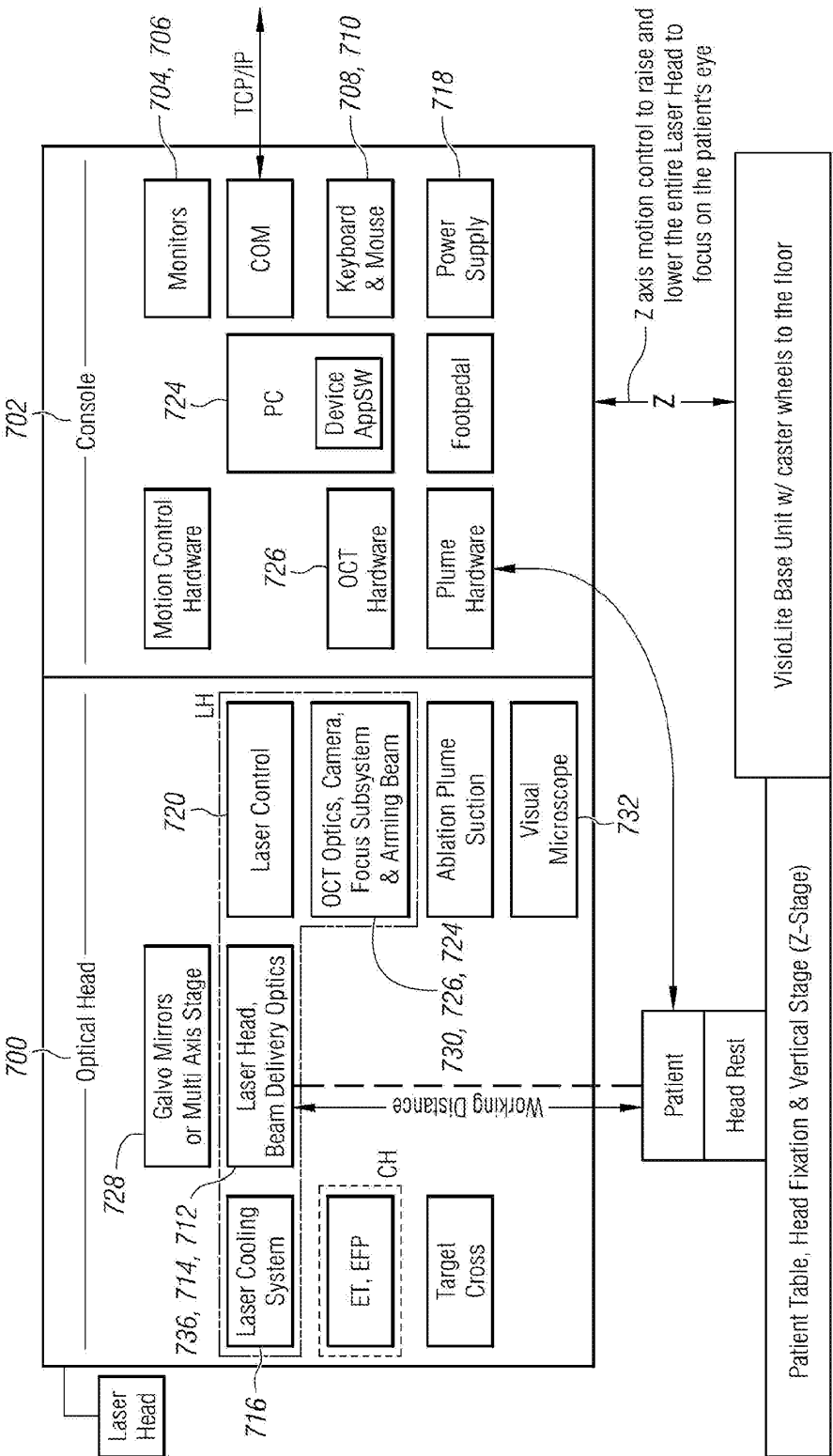


Fig. 9: System with Headrest, Z axis motion of Laser Head

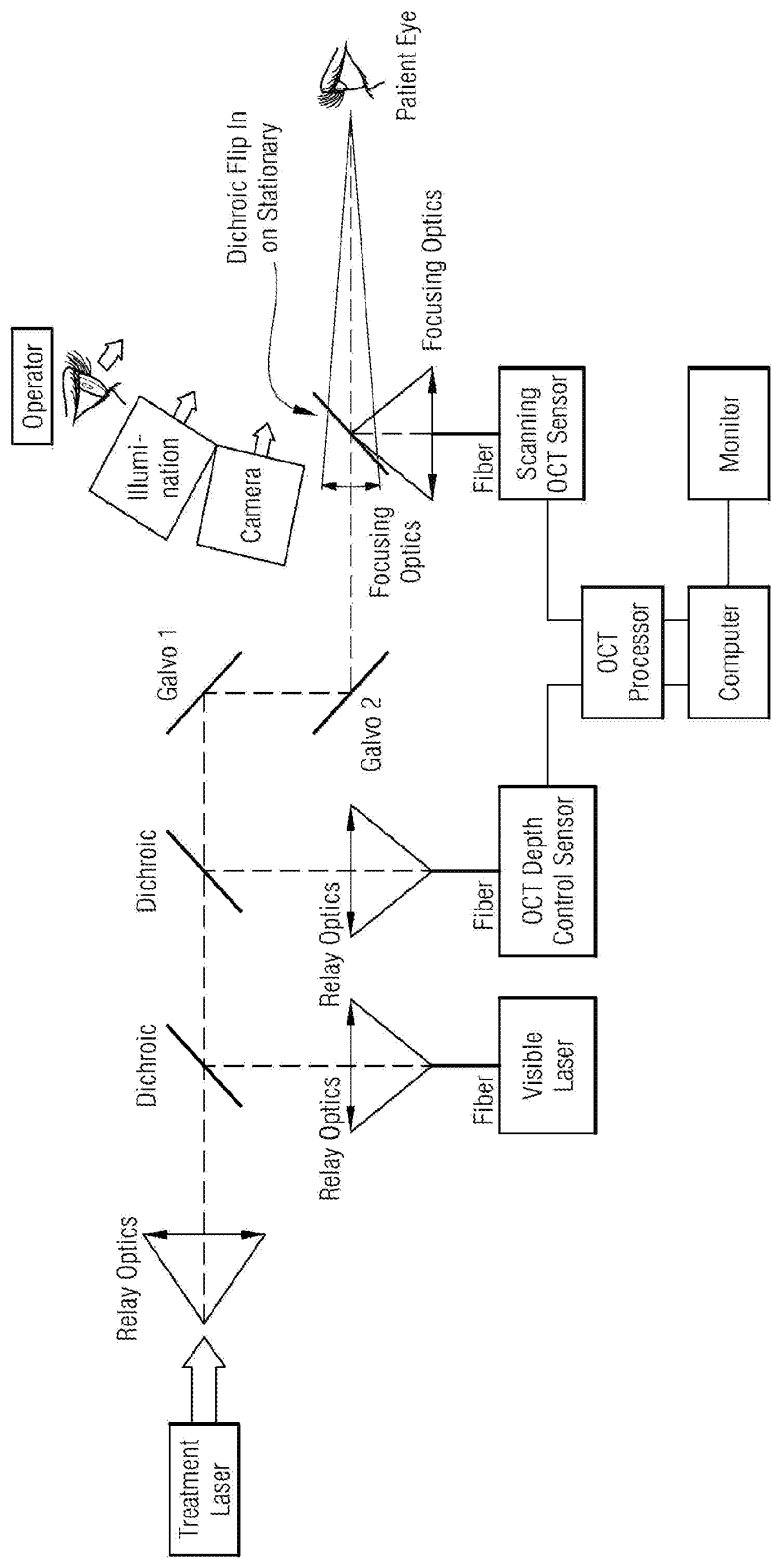


Fig. 10: System with Galvo mirrors, separate visible laser and OCT/DC fibers combined into treatment laser axis and doctor view of treatment

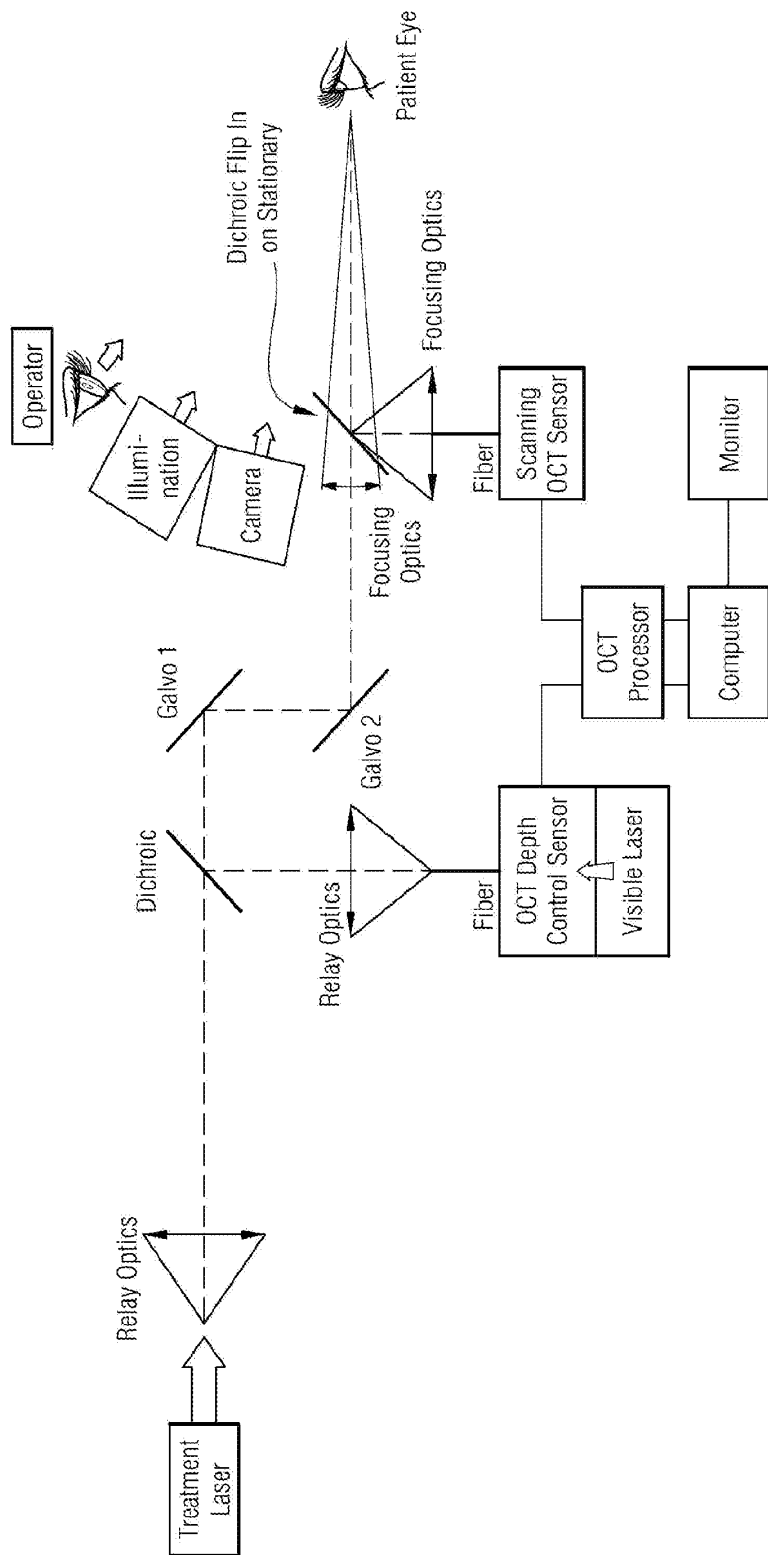


Fig. 11: System that Combines OCT/DC and Visible laser through a single fiber and shared relay lens with Treatment laser with Control and display

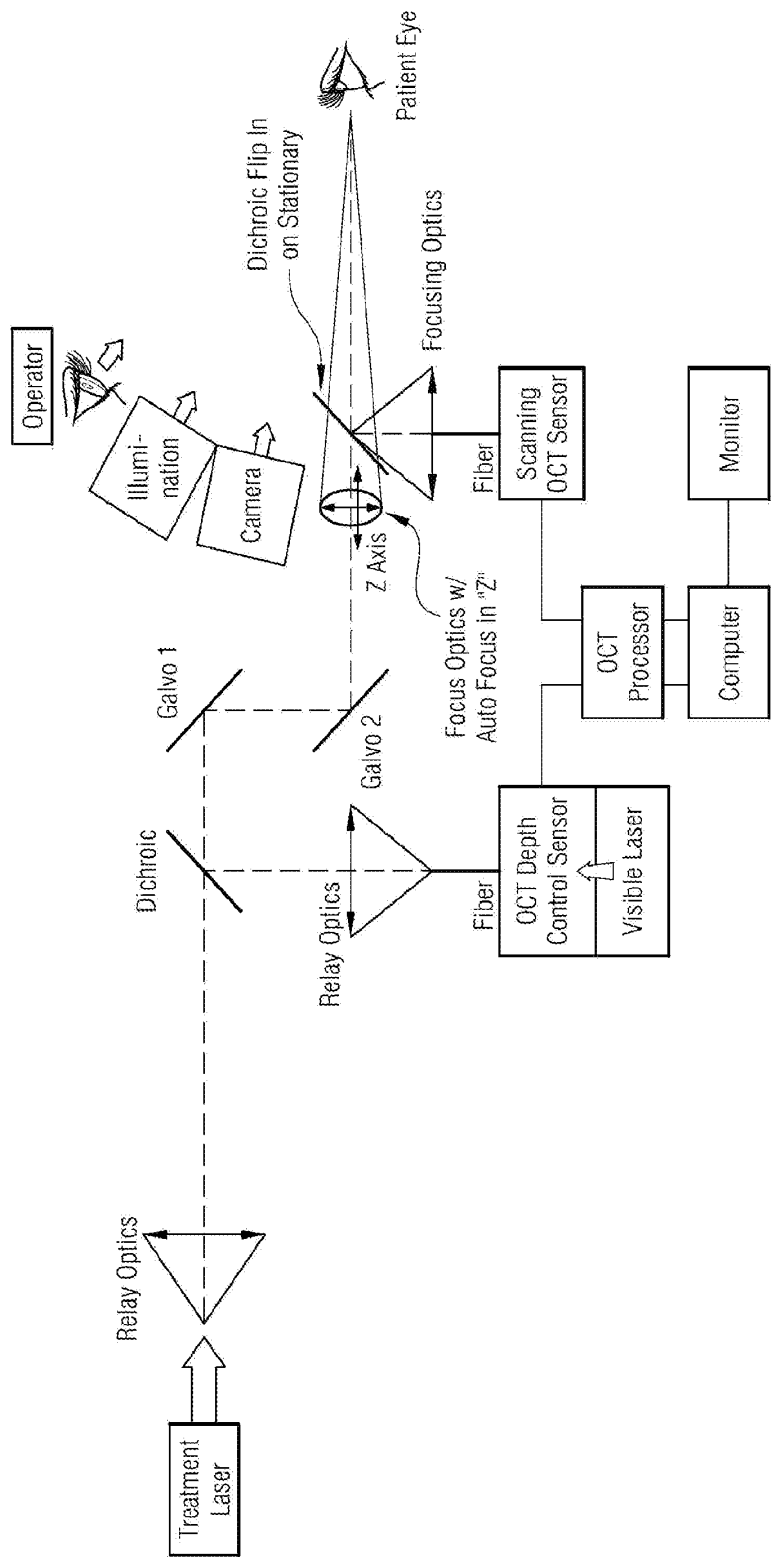


Fig. 12: Same as Fig AH but AF lens and shows dual function OCT system

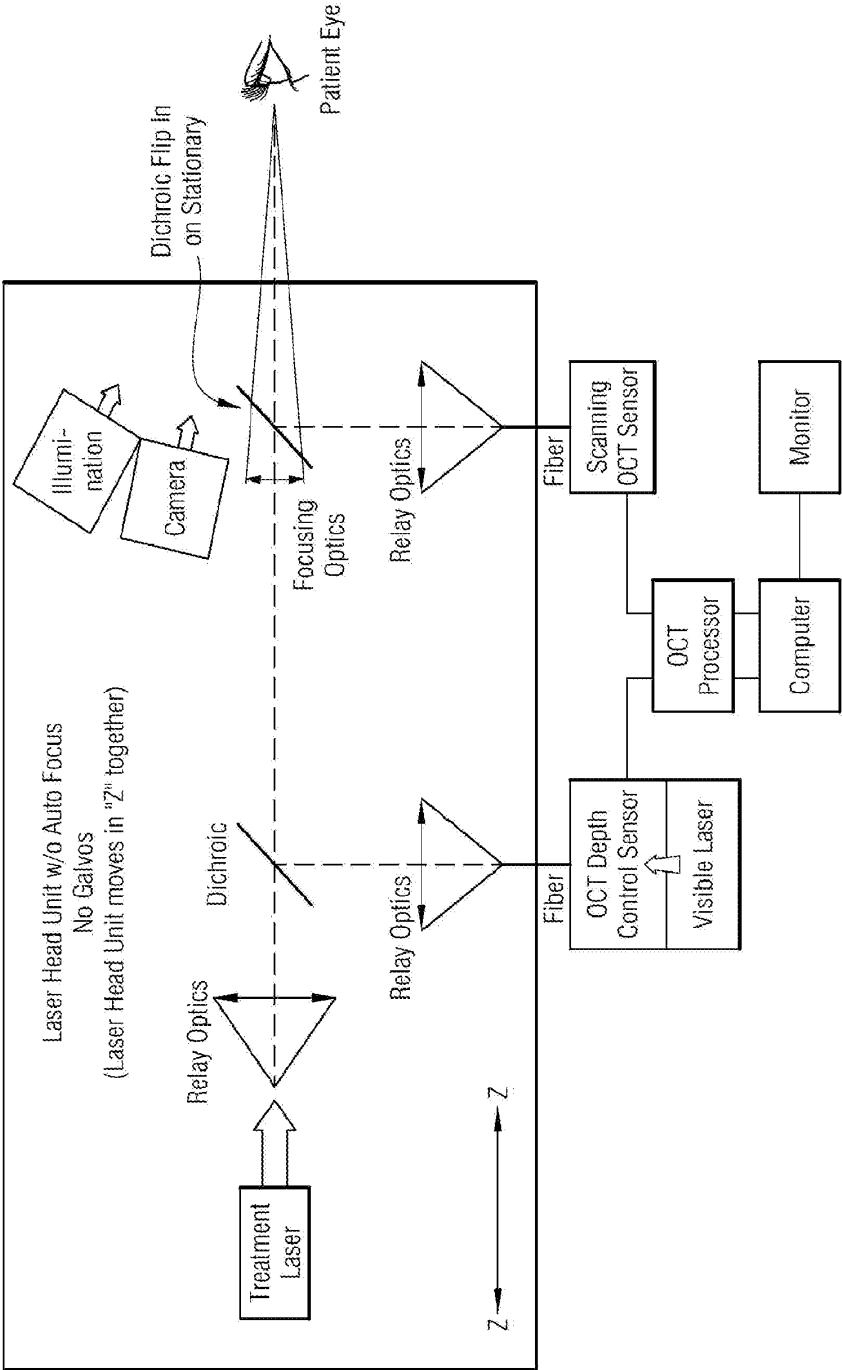


Fig. 13: Fig. A1 with no galvo, 5 axis Head and separate Z motion

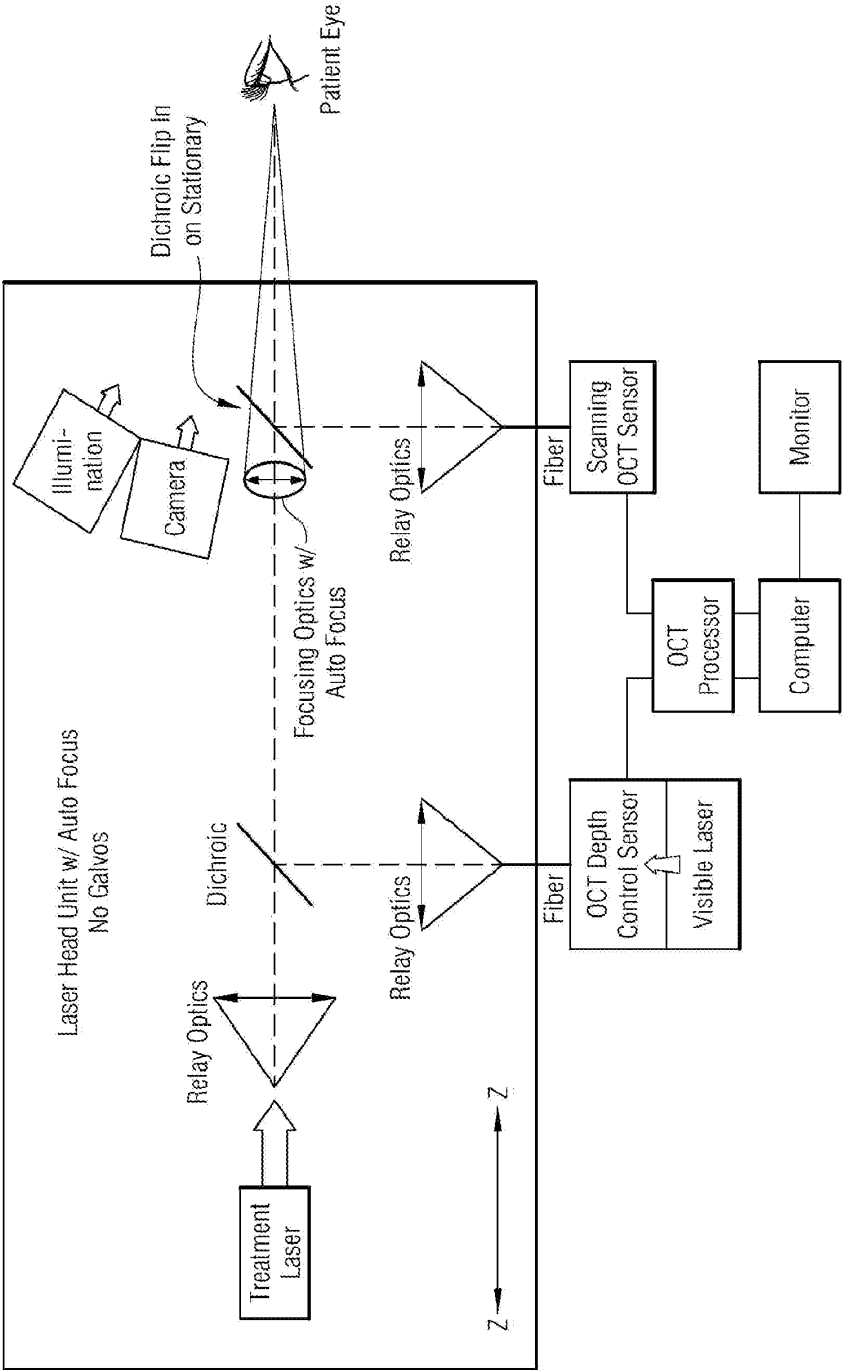


Fig. 14: Like Fig AJ but with no galvos, 6 axis with AF lens assembly

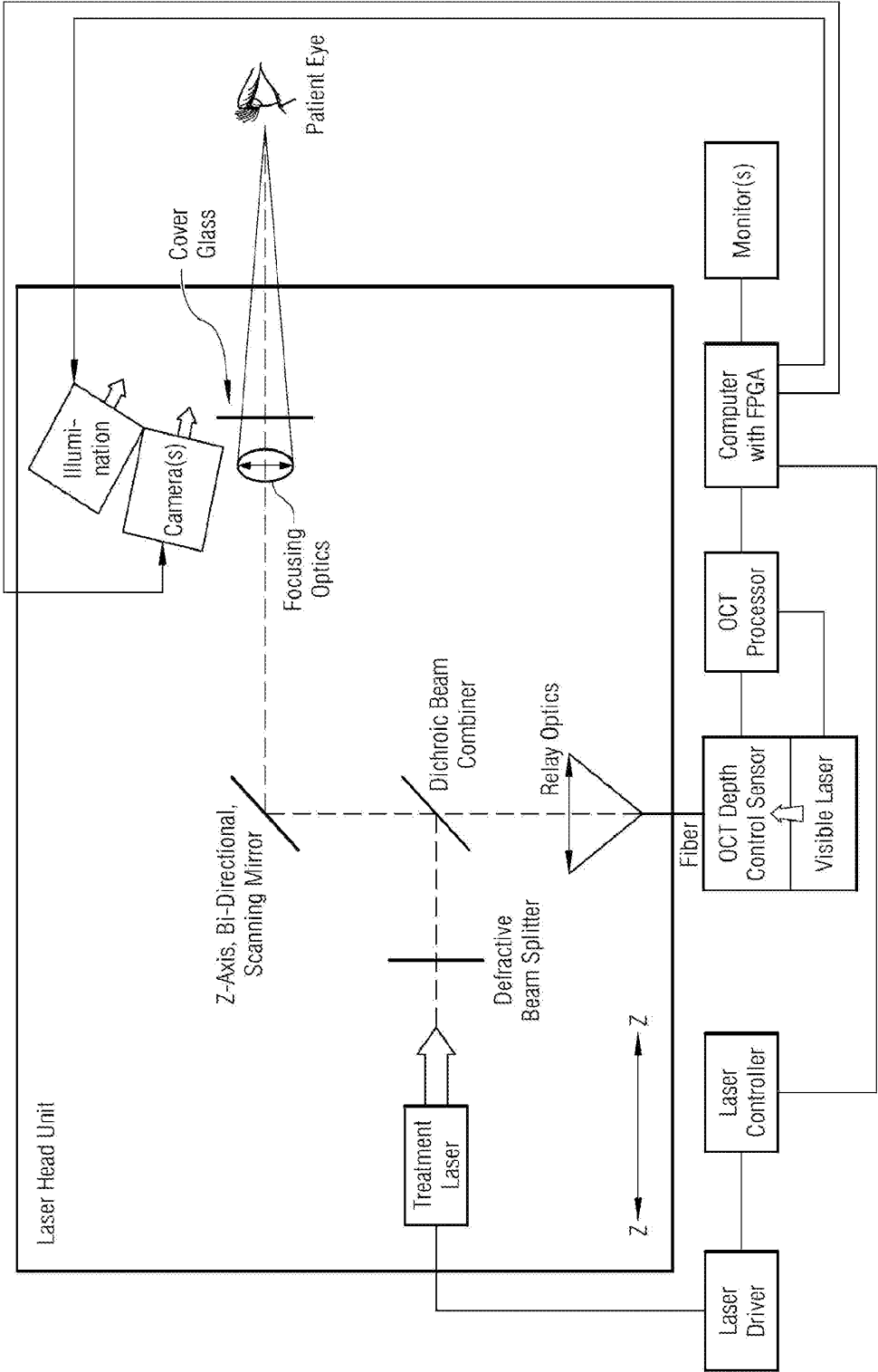


Figure 15: System with Integrated OCT Depth Control & Scanning

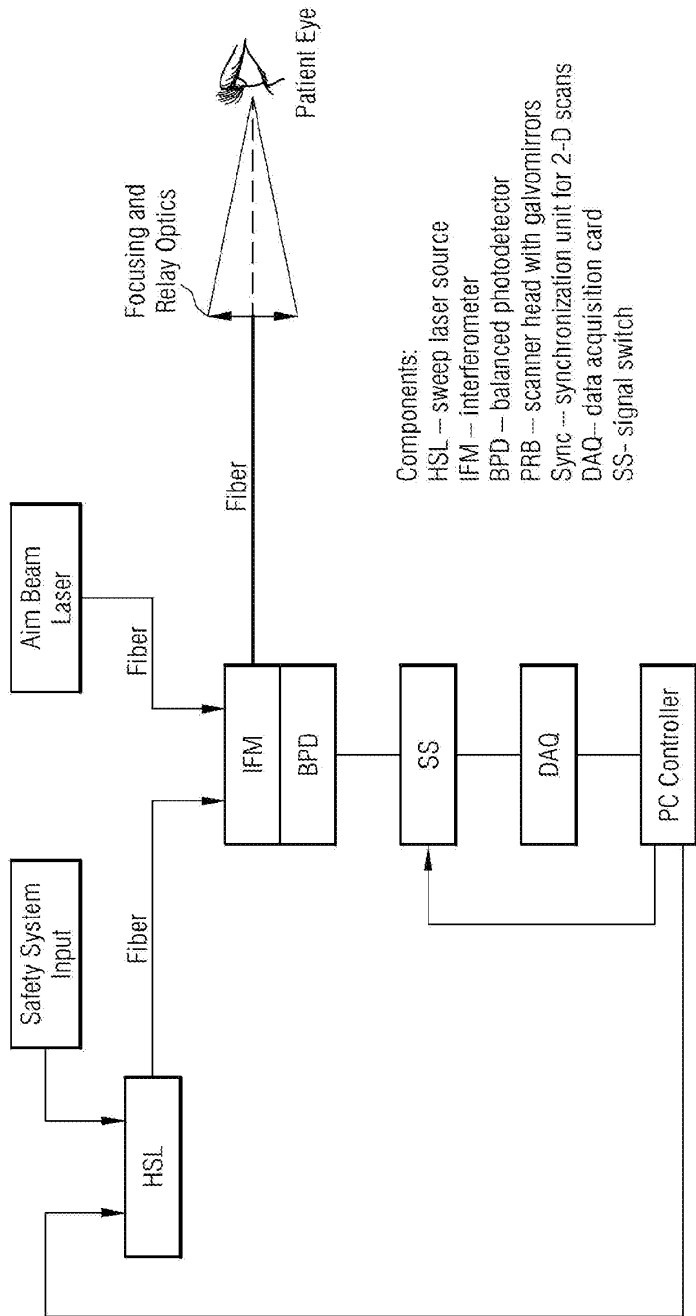


Fig. 16: OCT Control System with Depth Control with visible laser included

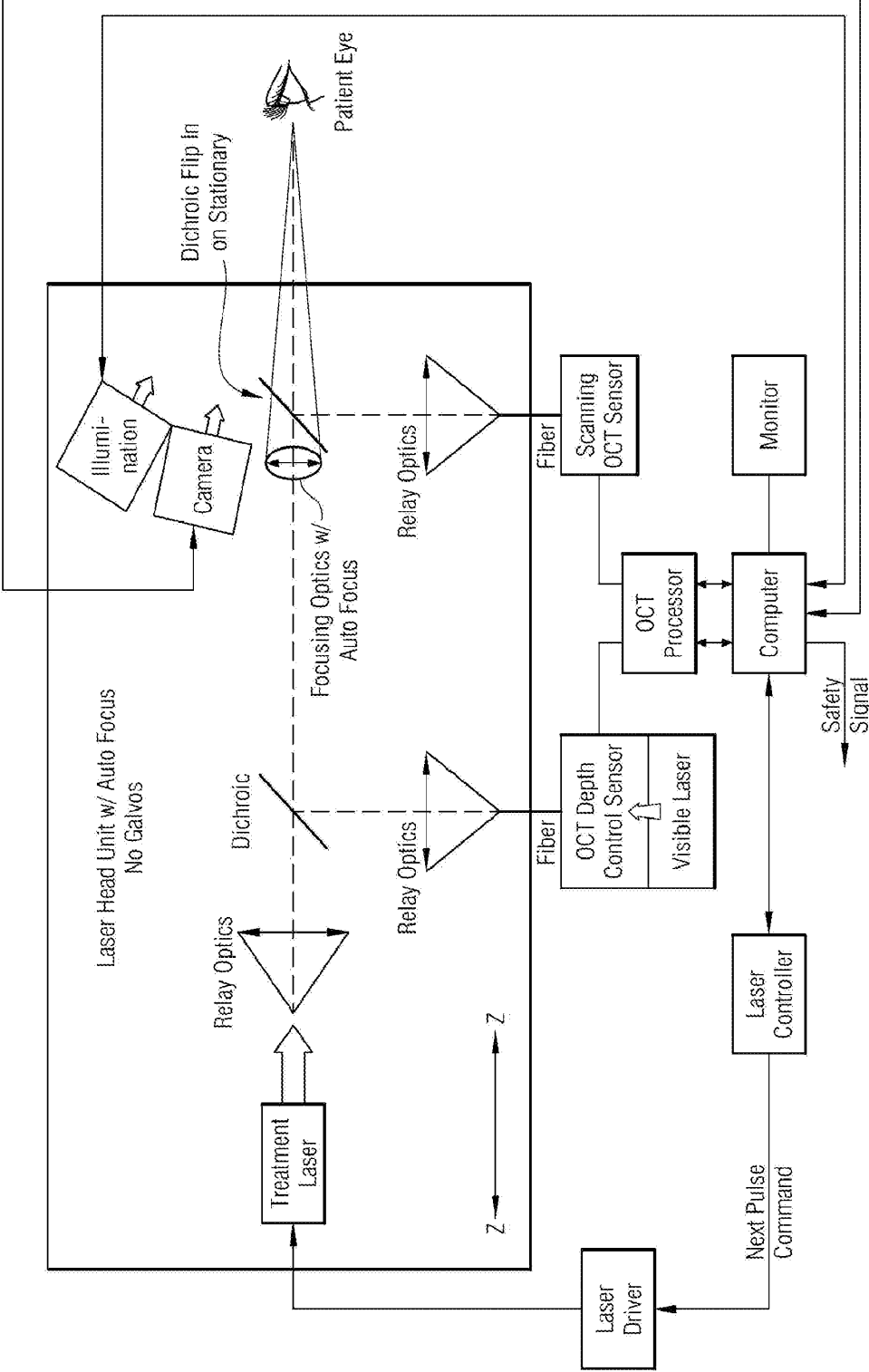
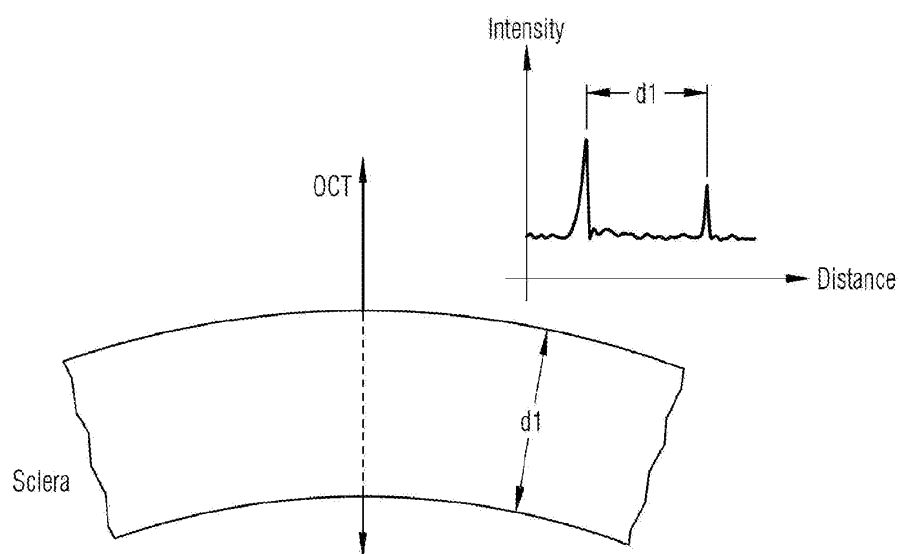
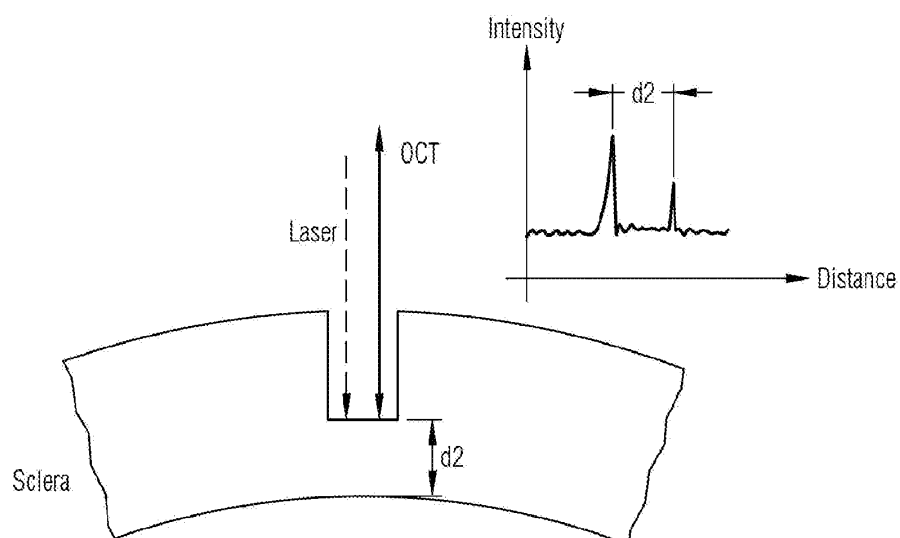


Fig. 17: Bio-Feedback System Control (OCT and/or Camera)

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Before ablation treatment OCT signal provides top surface of eye and the inside surface of the Sclera. Sclera thickness ($d1$ can be calculated)



After ablation of a single laser pulse, the OCT signal provides bottom surface of the micropore and the inside surface of the Sclera. Remaining Sclera thickness ($d2$) can be calculated, expressed as a % of total thickness.

Figure 18: OCT Depth method to measure pore depth and scleral thickness

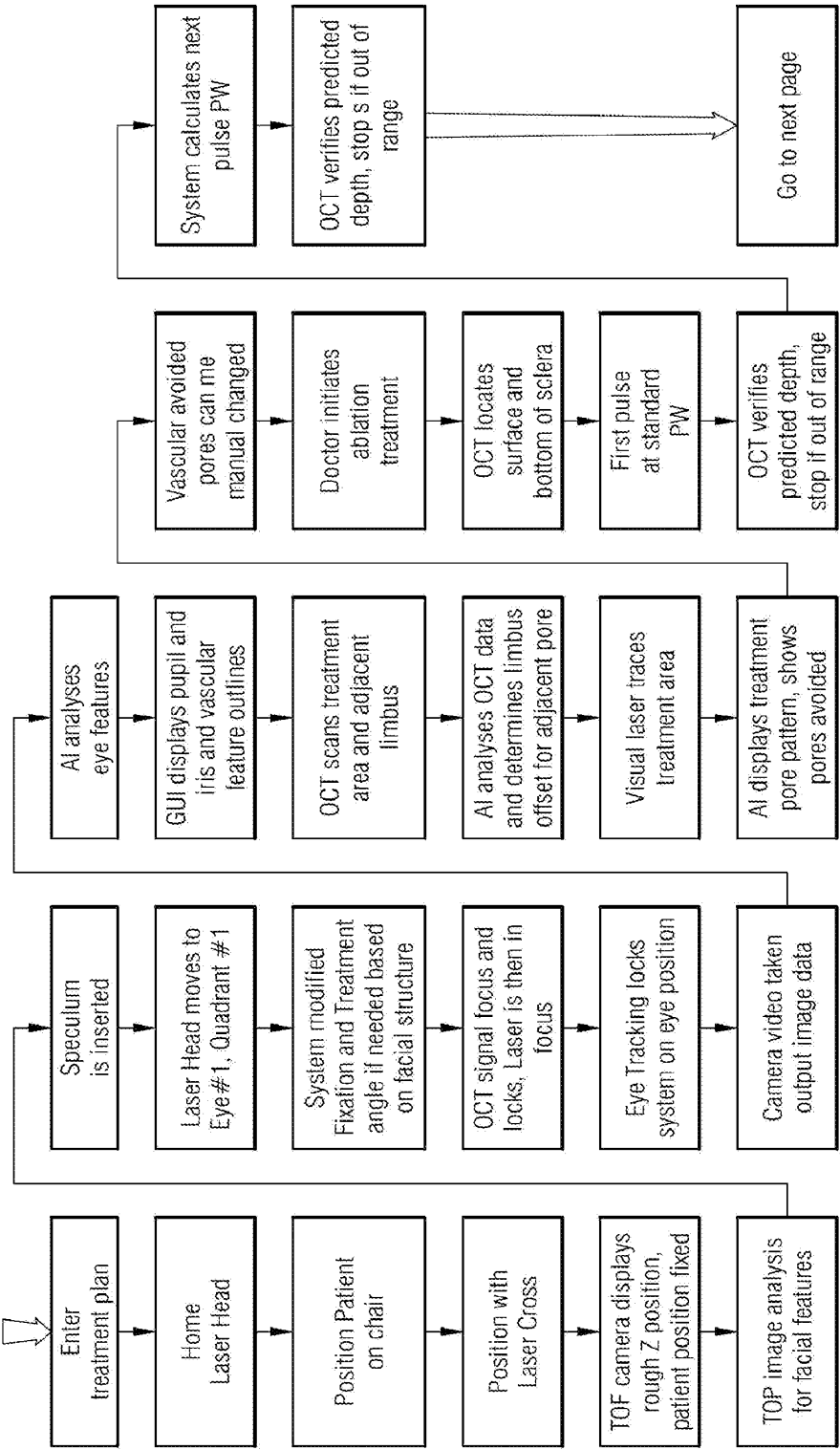


Fig. 19: Workflow process steps – pg. 1

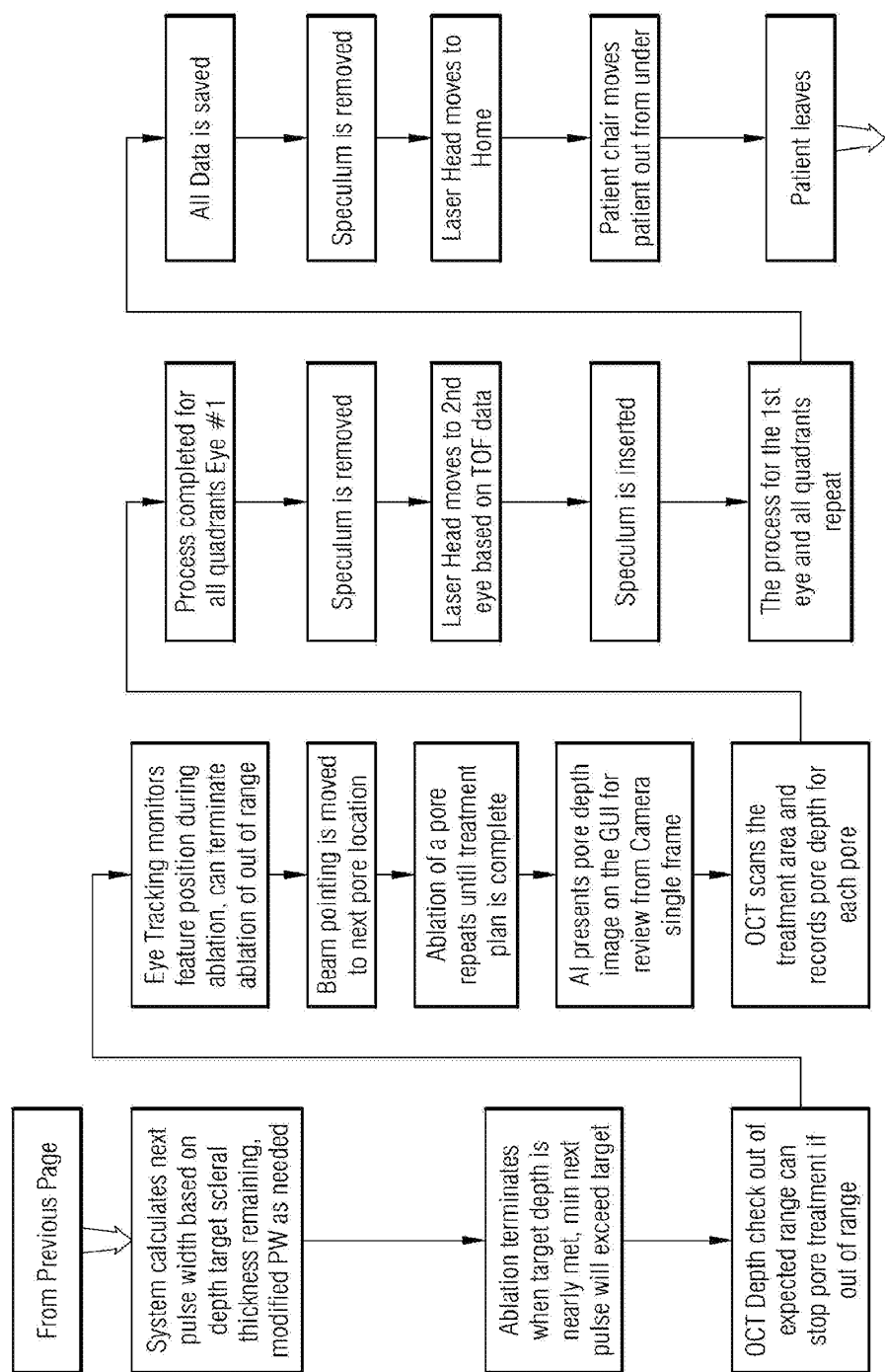


Fig. 20: Workflow process steps- pg. 2

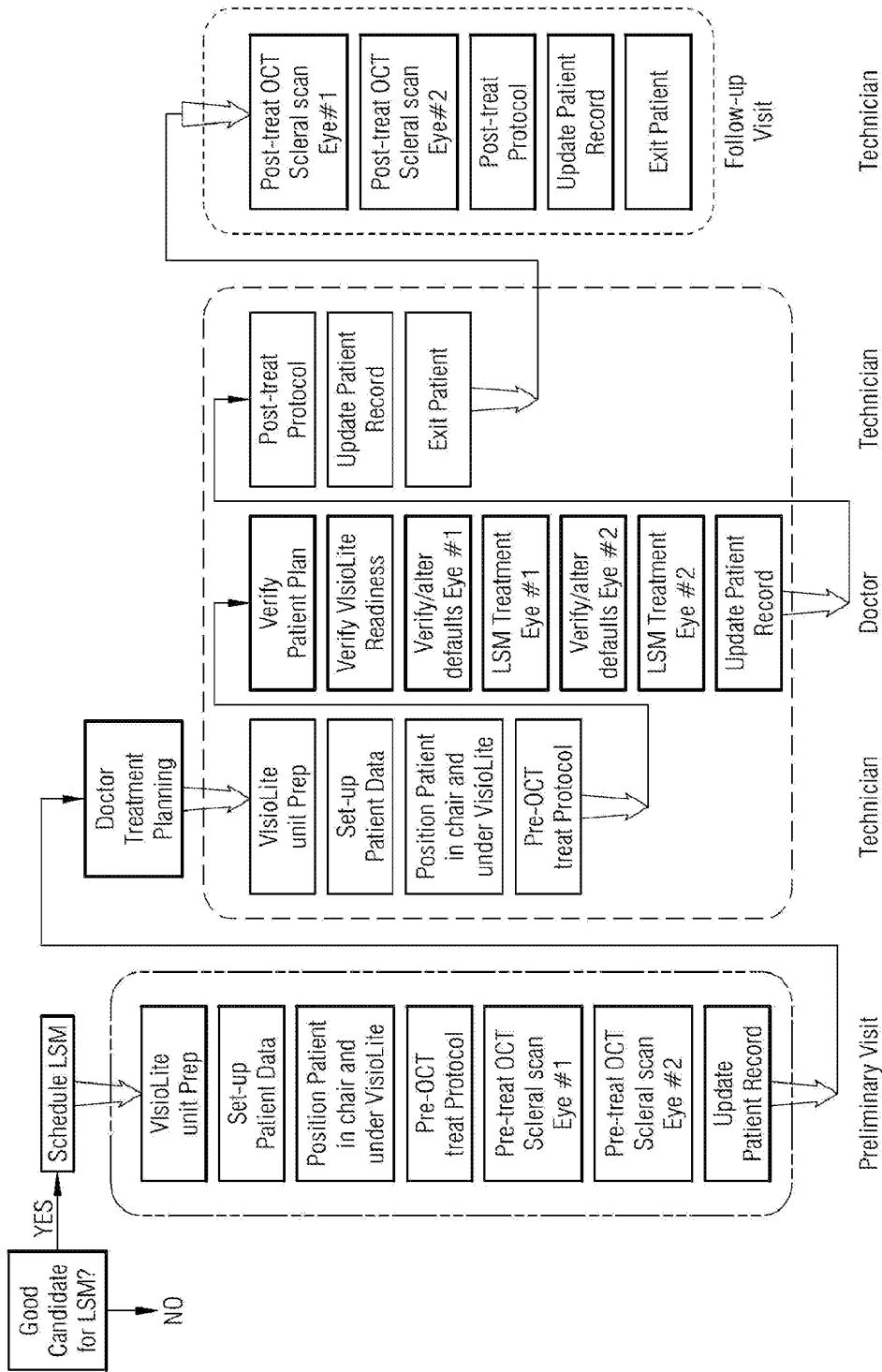


Fig. 21: Workflow Diagram including OCT & LSM pre-planning with off-line OCT scanner

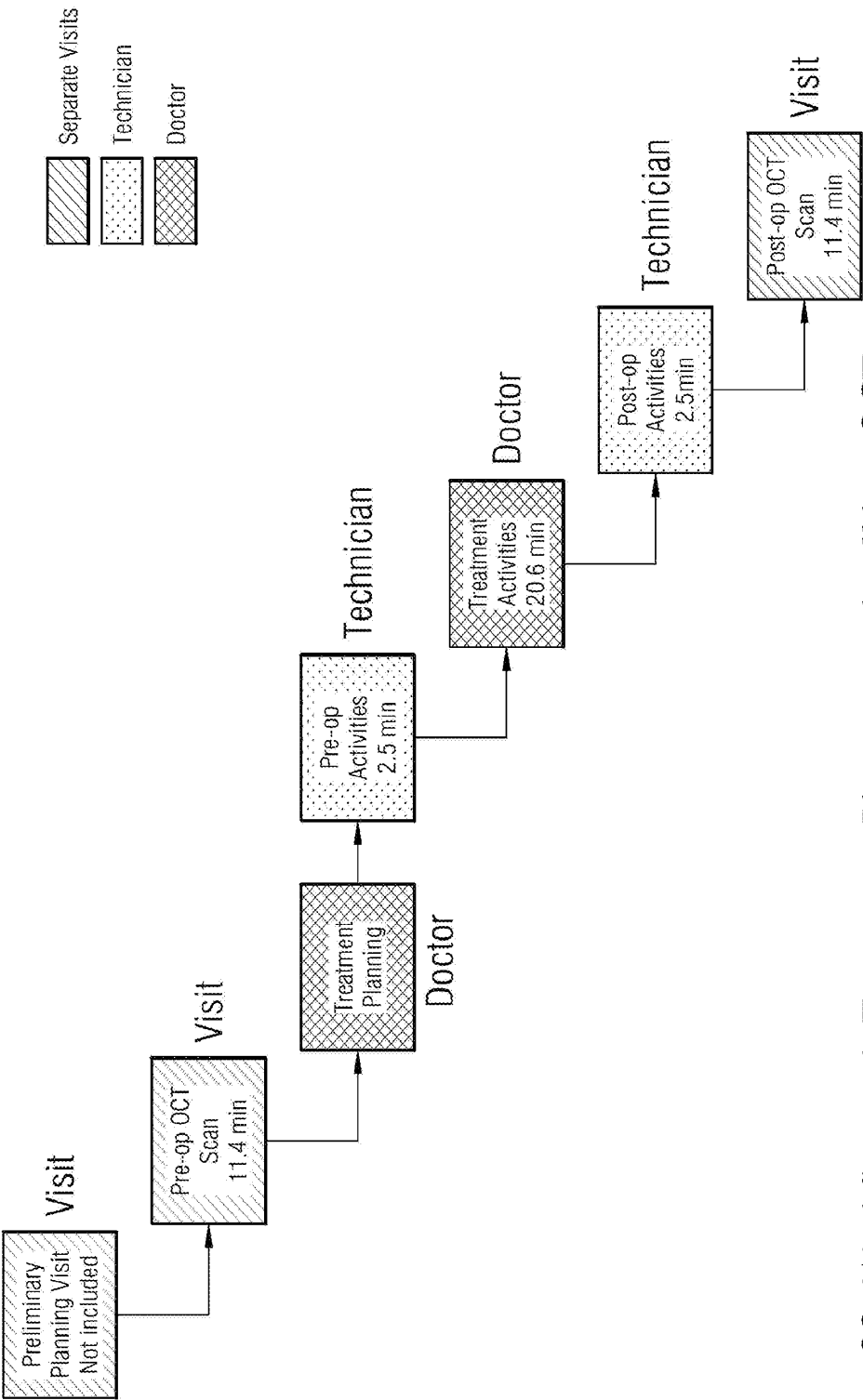


Fig. 22: Workflow with Treatment Planning with off-line OCT
(OCT scans both eyes by tech on another day)

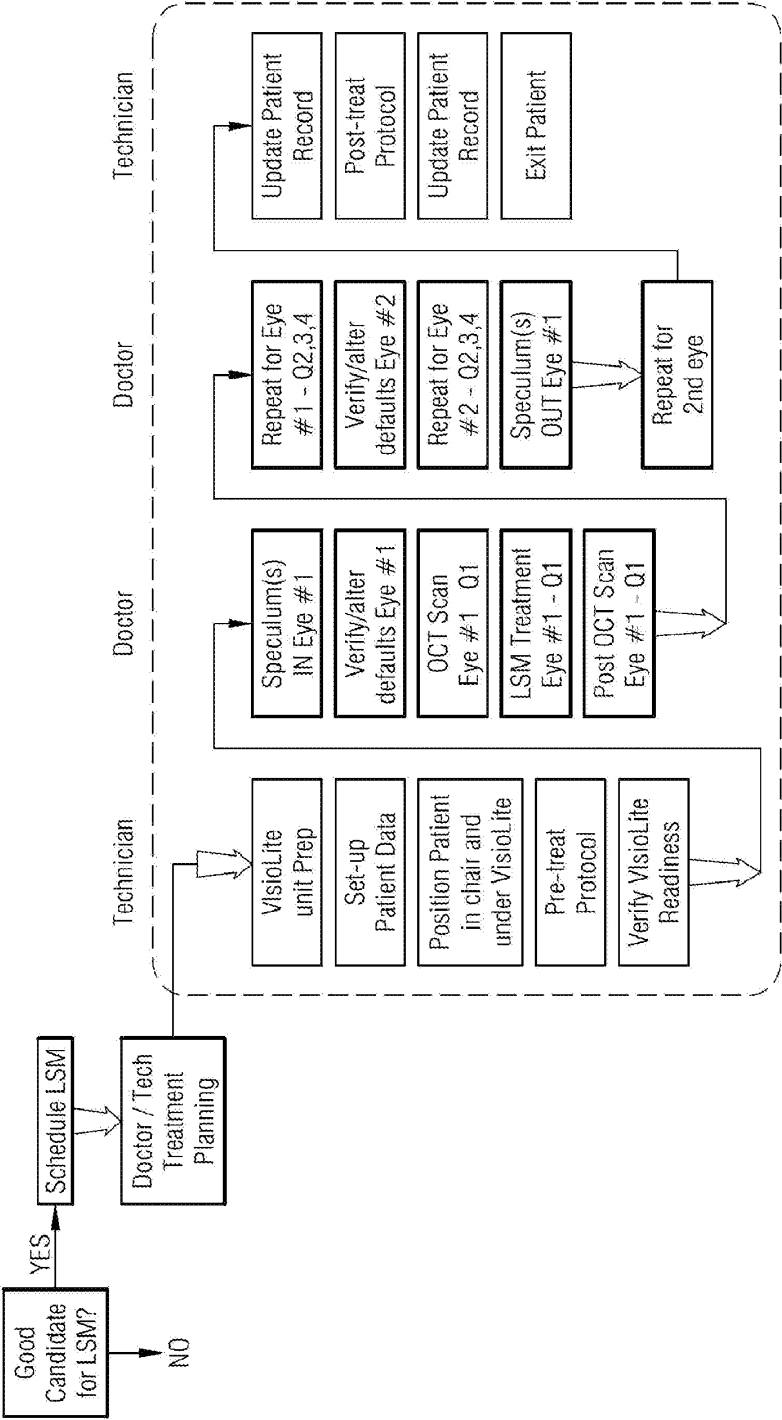


Fig. 23: Workflow Diagram including Integrated OCT Scanner

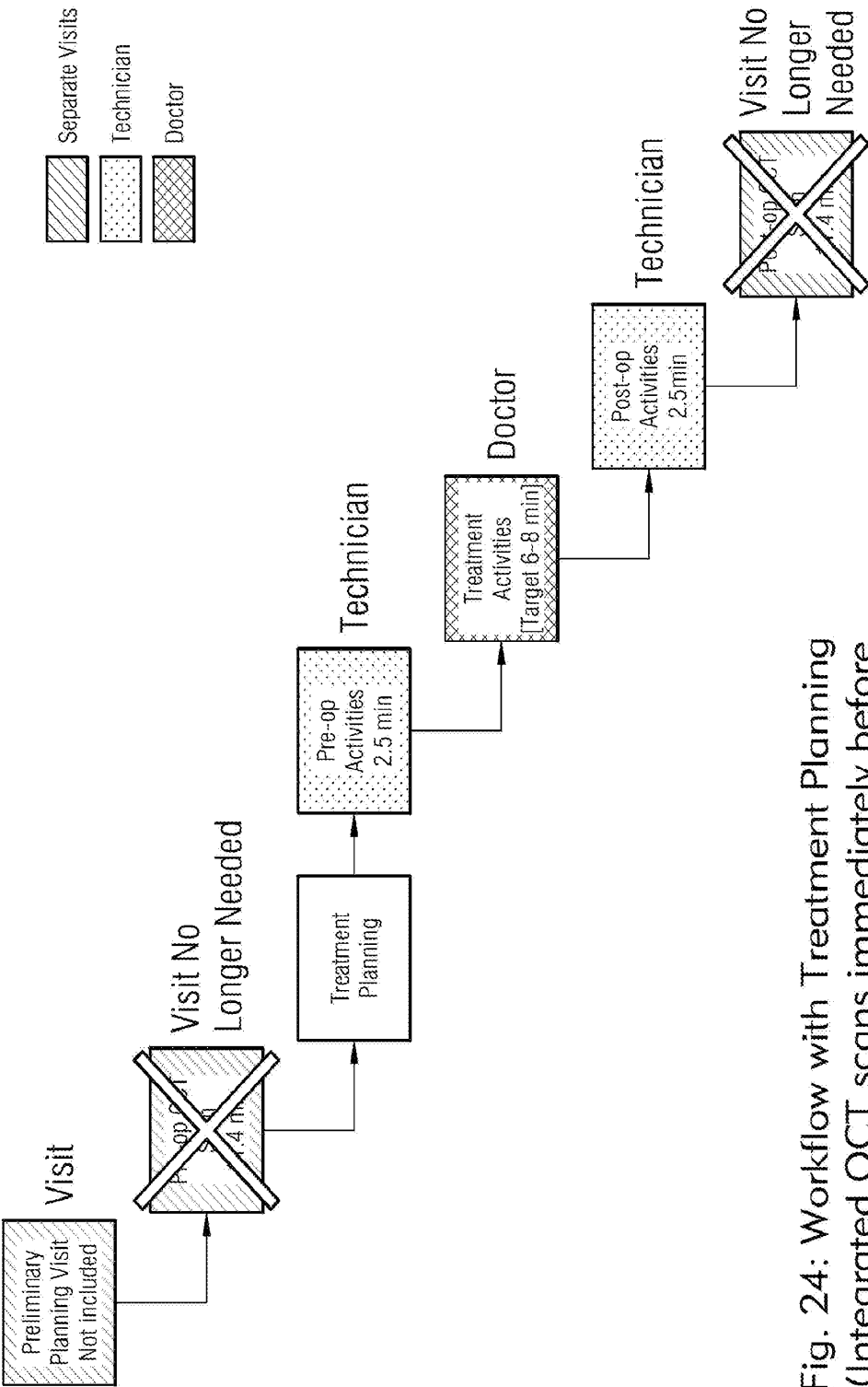


Fig. 24: Workflow with Treatment Planning (Integrated OCT scans immediately before and after LSM treatment by Quadrant)

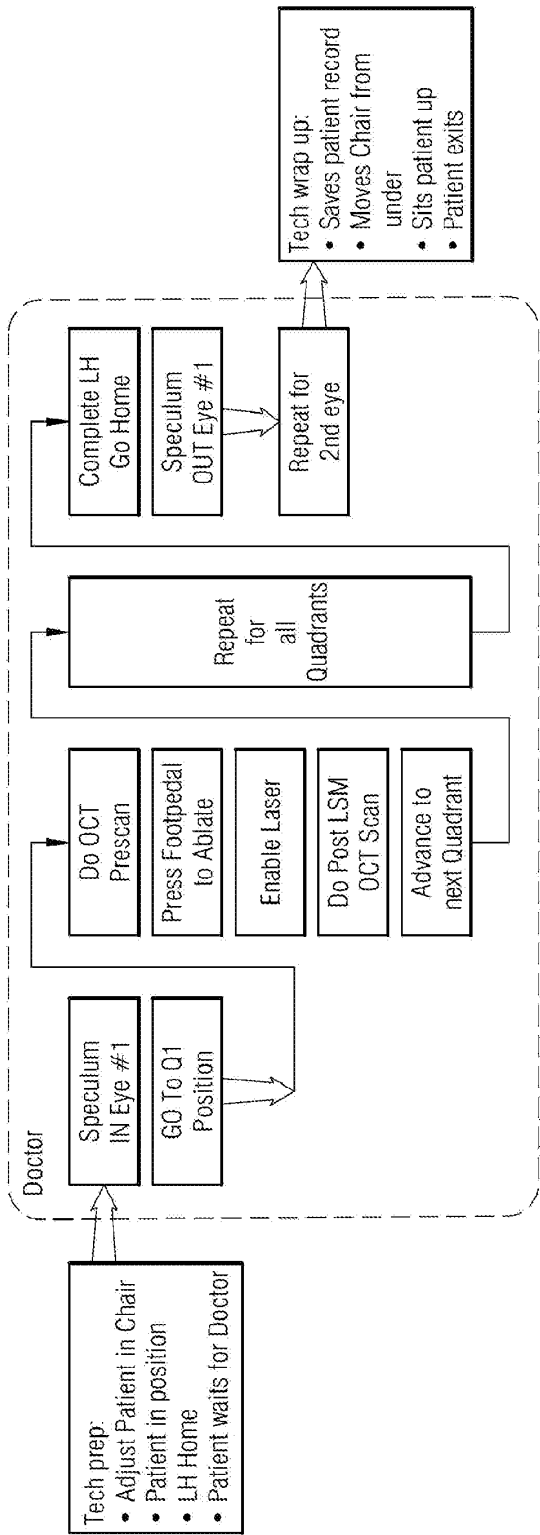


Fig. 25: Flow chart for Doctor steps in LSM treatment with Integrated OCT Scanner

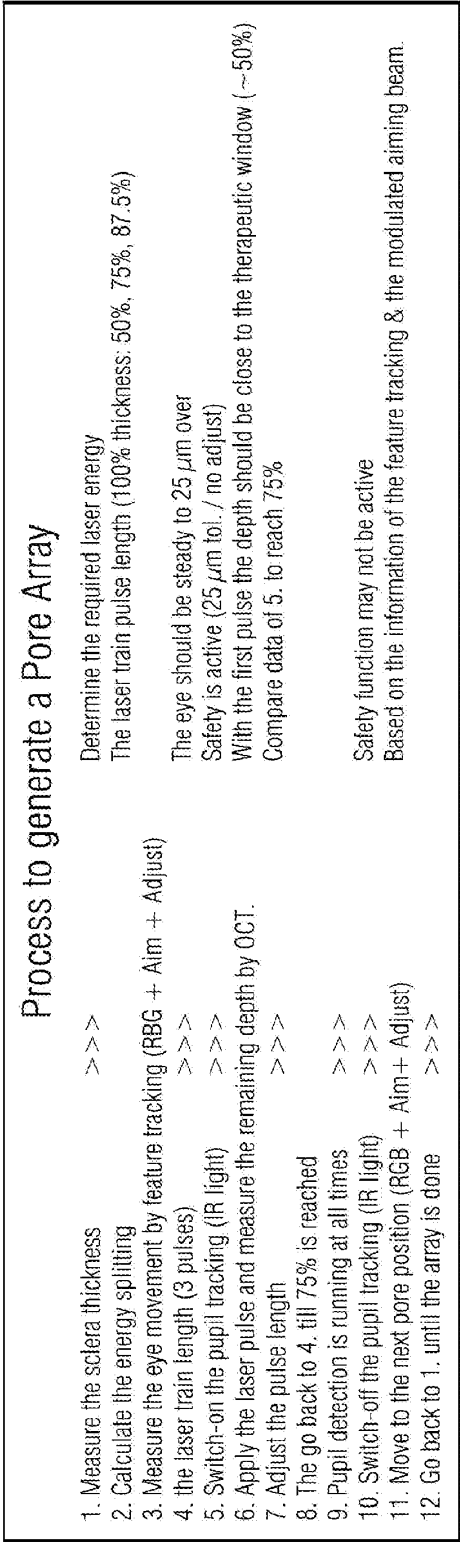


Fig. 26: Flow diagram for Pore Array Generation

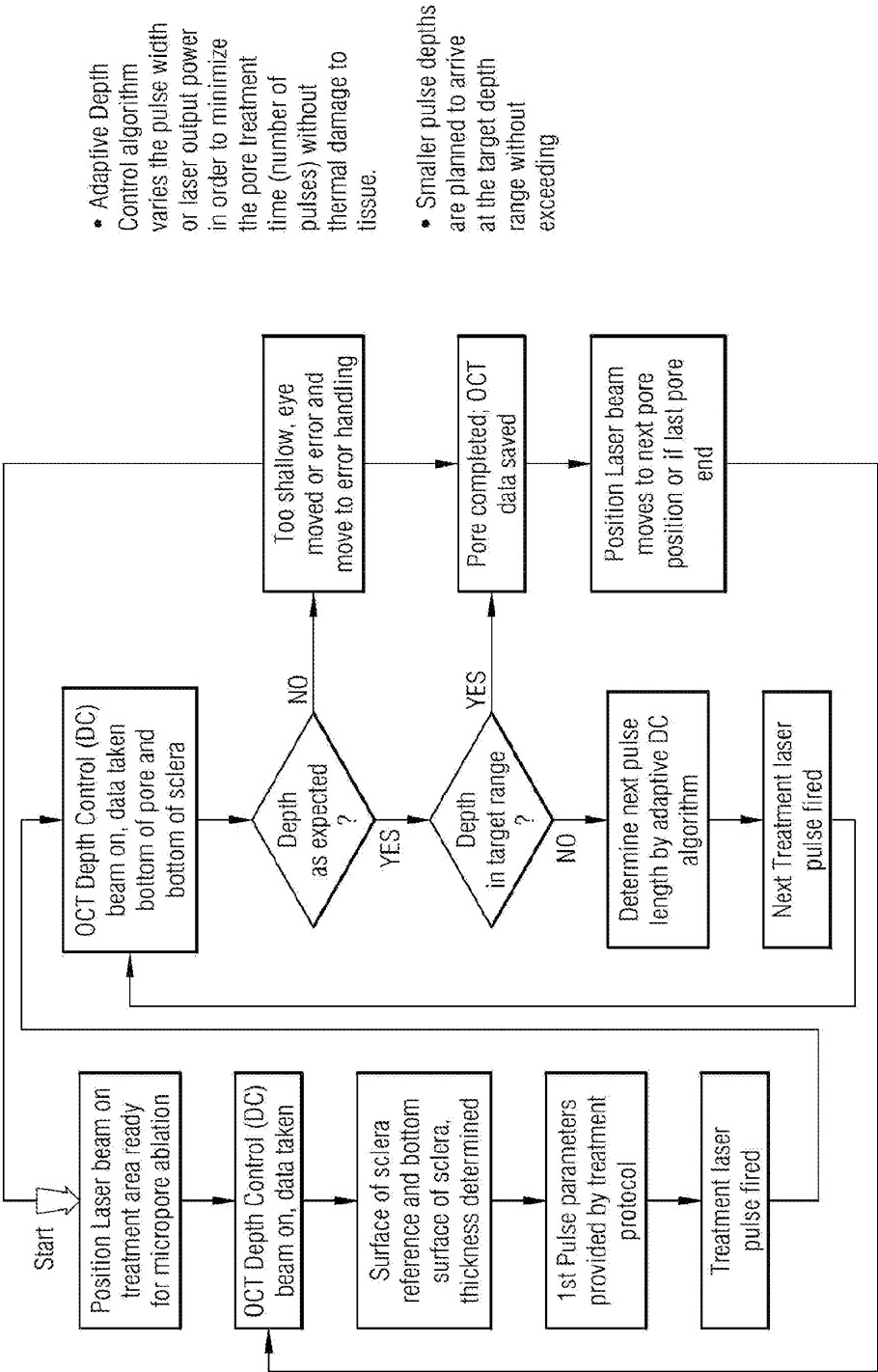


Fig. 27: Method of OCT/DC Adaptive control and OCT/DC tracking eye motion

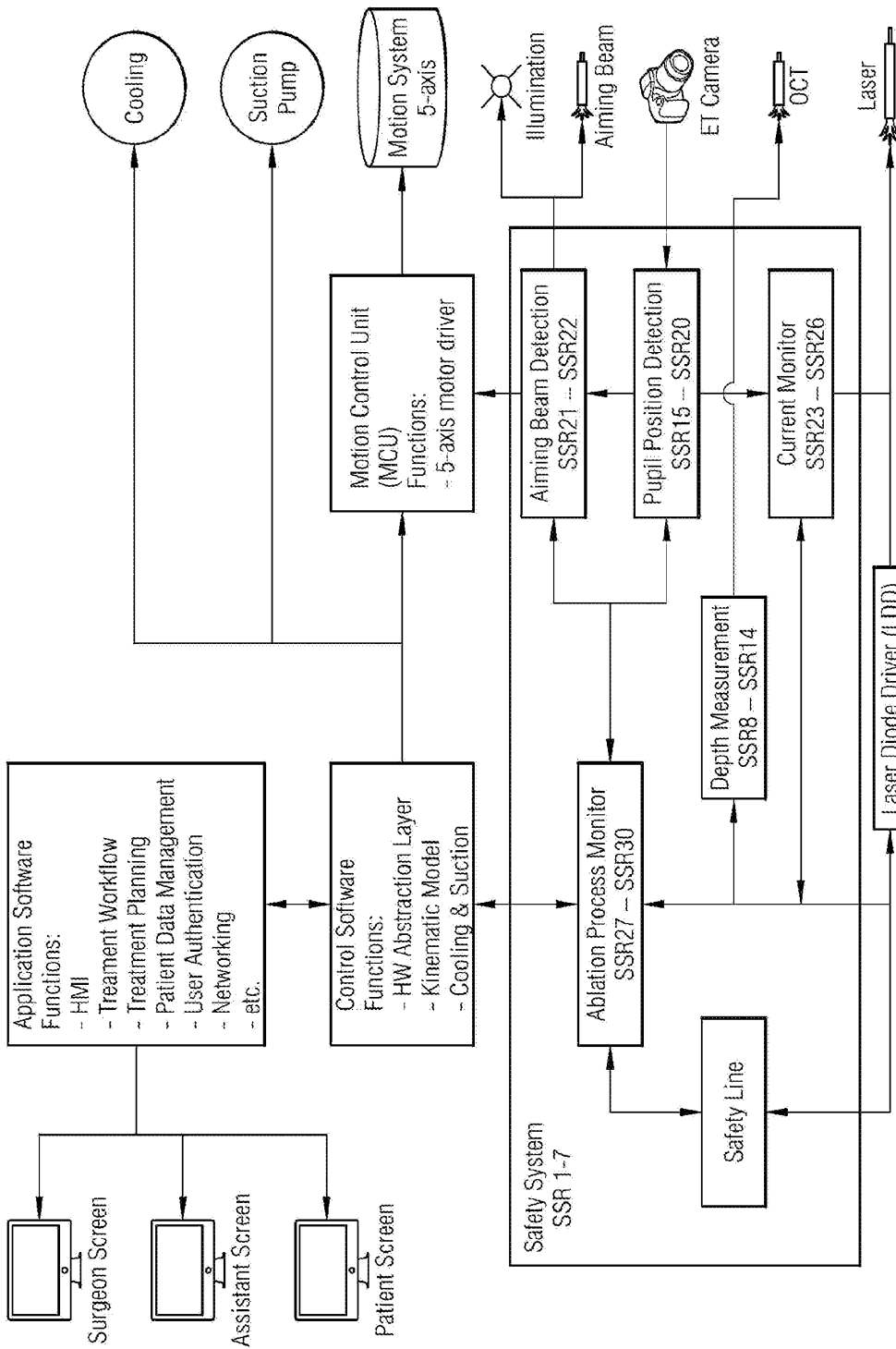


Fig. 28: System block diagram integrating sub-systems and FPGA w/ safety controls

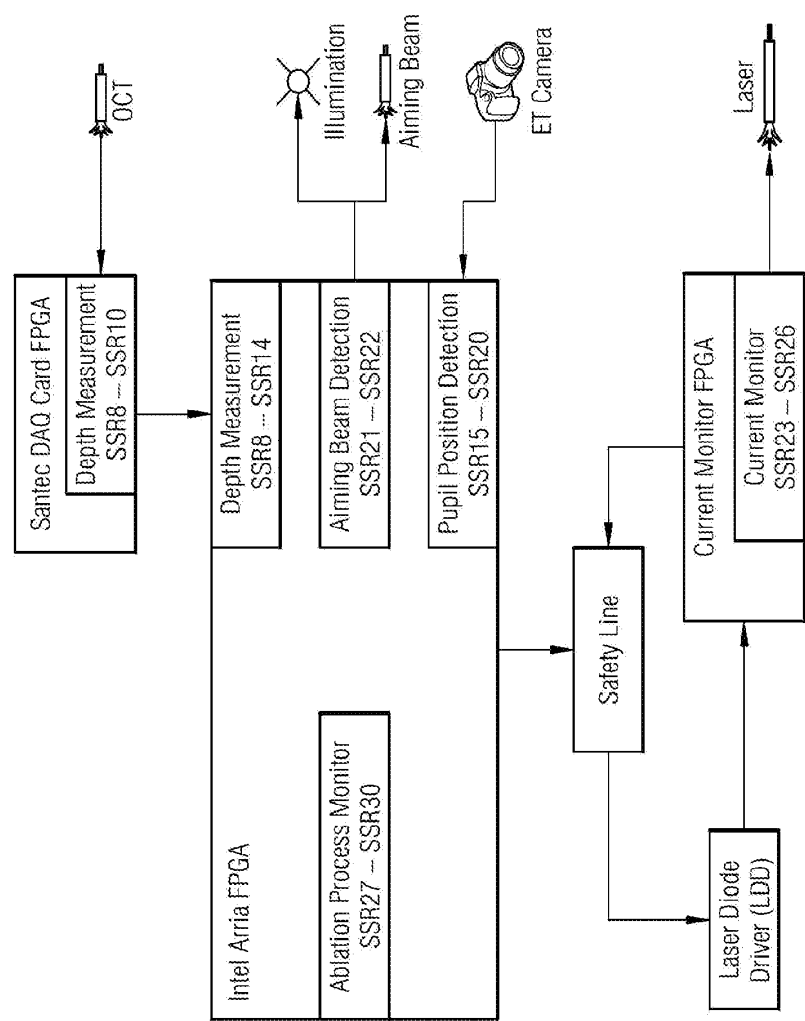


Fig. 29: System block diagram integrating sub-systems and FPGA w/ safety controls

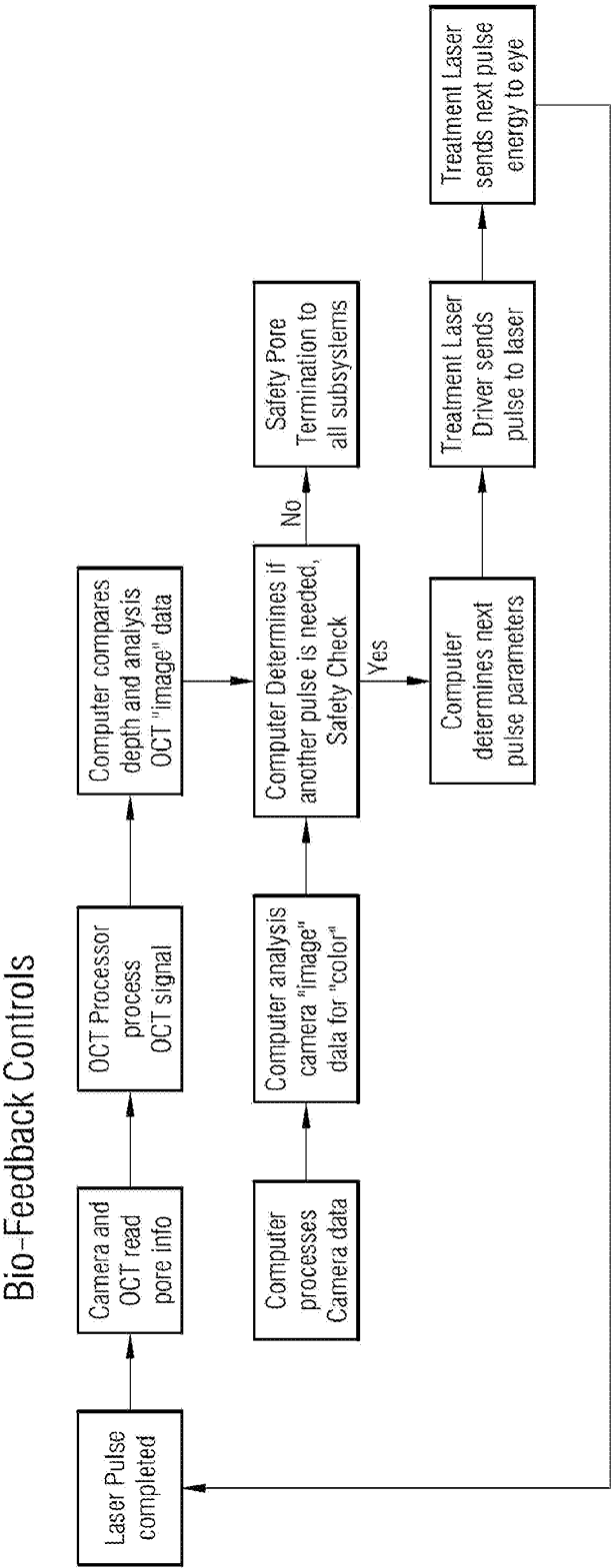


Fig. 30: Bio-Feedback Controls

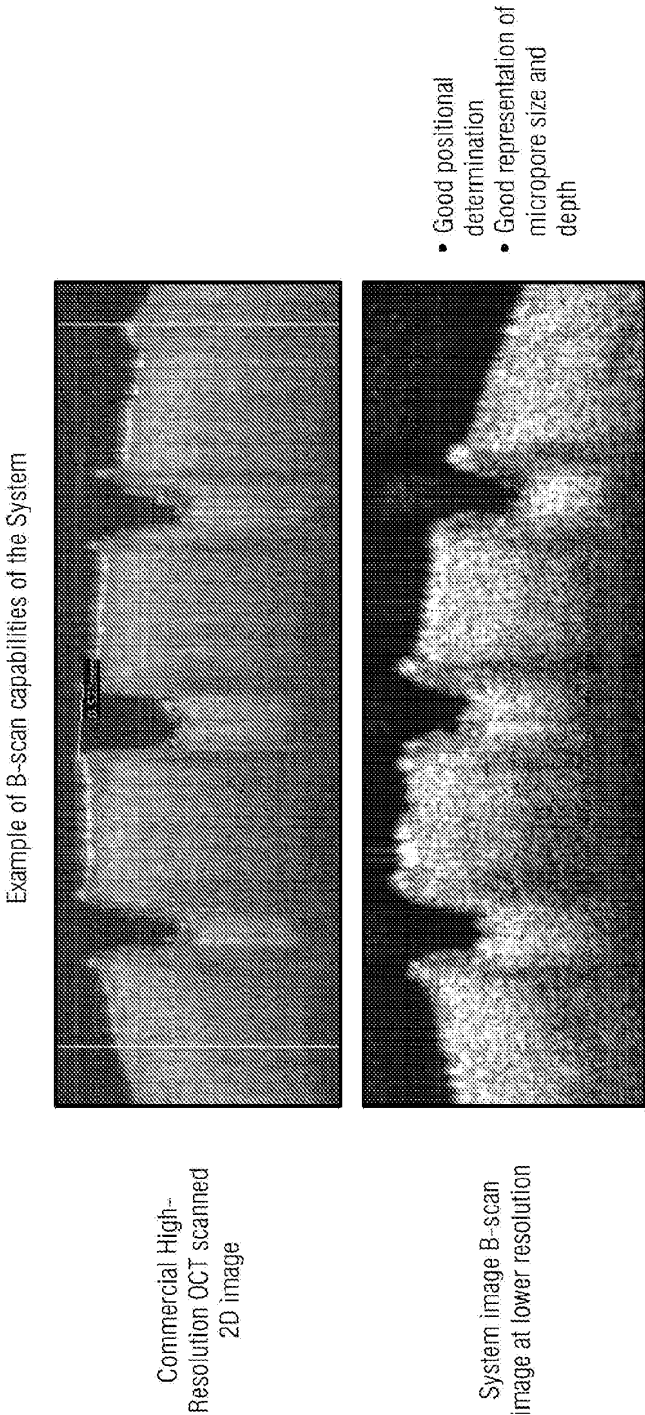


Fig. 31: OCT/DC (single line scan) over micropores to create OCT data and images

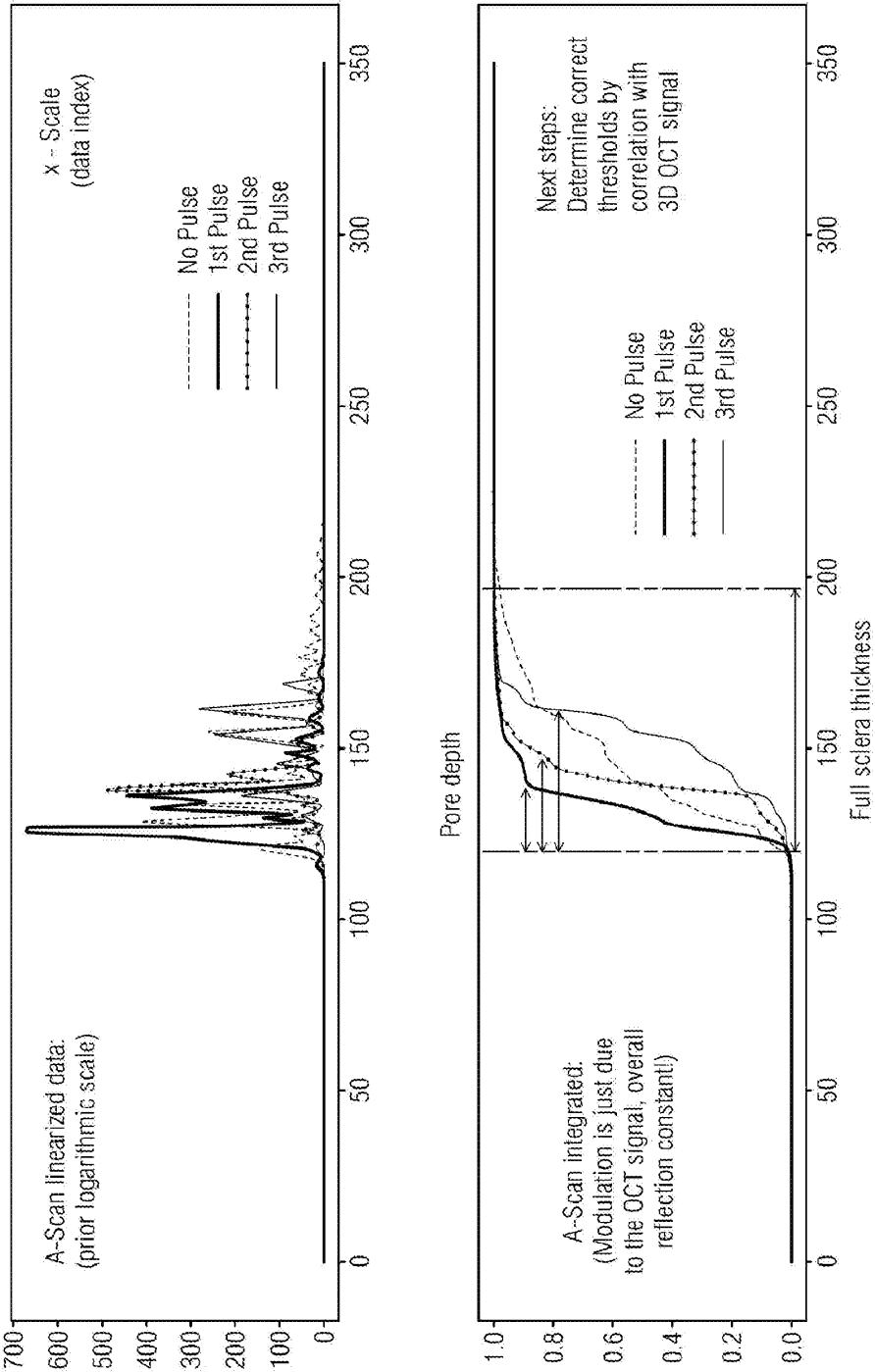
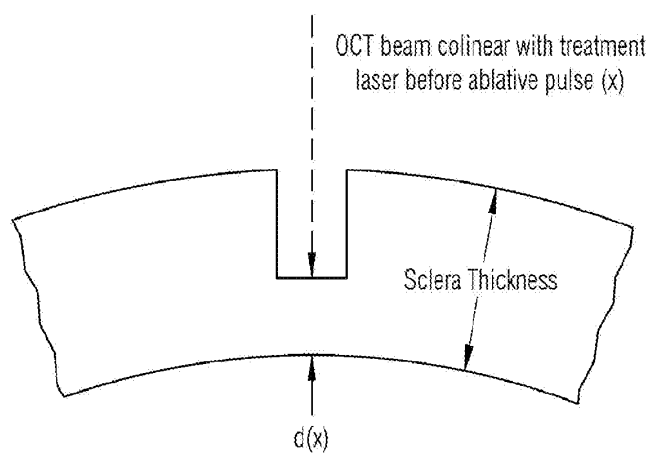


Fig. 32: Porcine Eye: 3 pulses - $d=0.36$ mm: A-Scan (Processed data)

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Pulse energy for the next pulse (x+1) has an expected micropore depth. If readings after the pulse do not increase as expected an out of range result can be communicated to the system controller. $d(x+1) \geq d(x)$

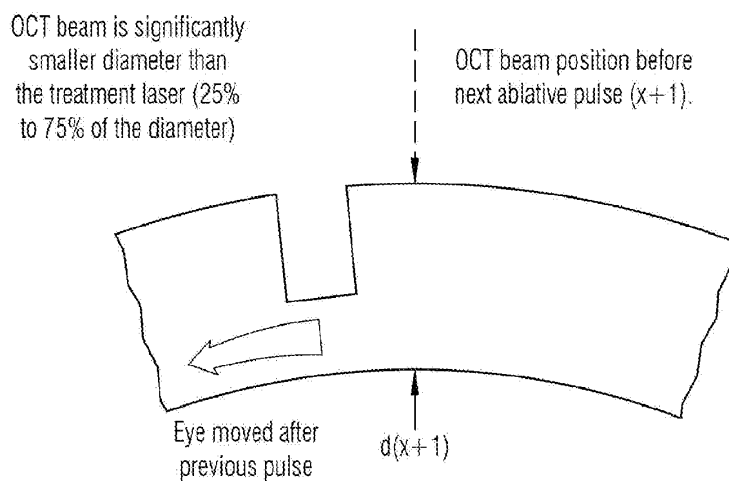


Fig. 33: OCT Depth method to monitor eye motion between pulses of ablation

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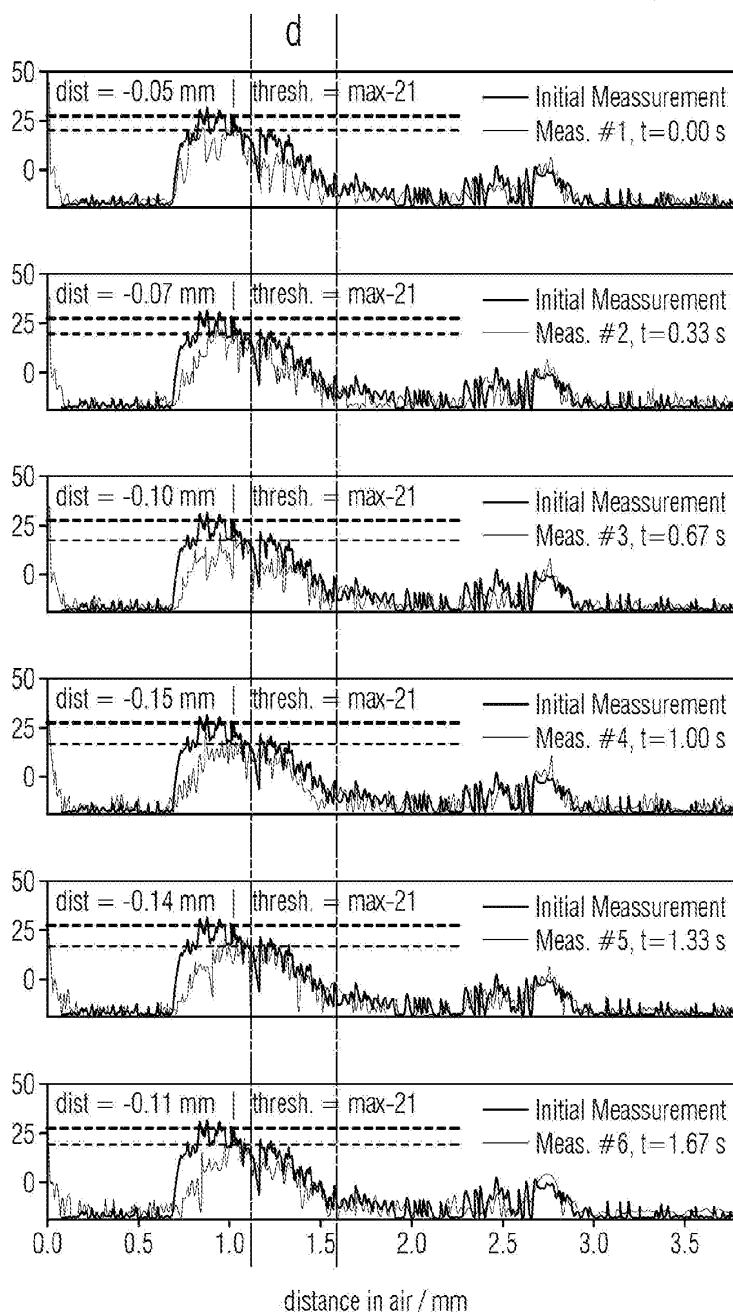
DC OCT signal: 2019-08-22-16-58 I=300 A, t=100 μ s, f=50 Hz, pulse #3

Fig. 34A: OCT Depth Control Signal with Porcine Eye:
3 pulses - d=0.36 mm: A-Scan (Unprocessed data)

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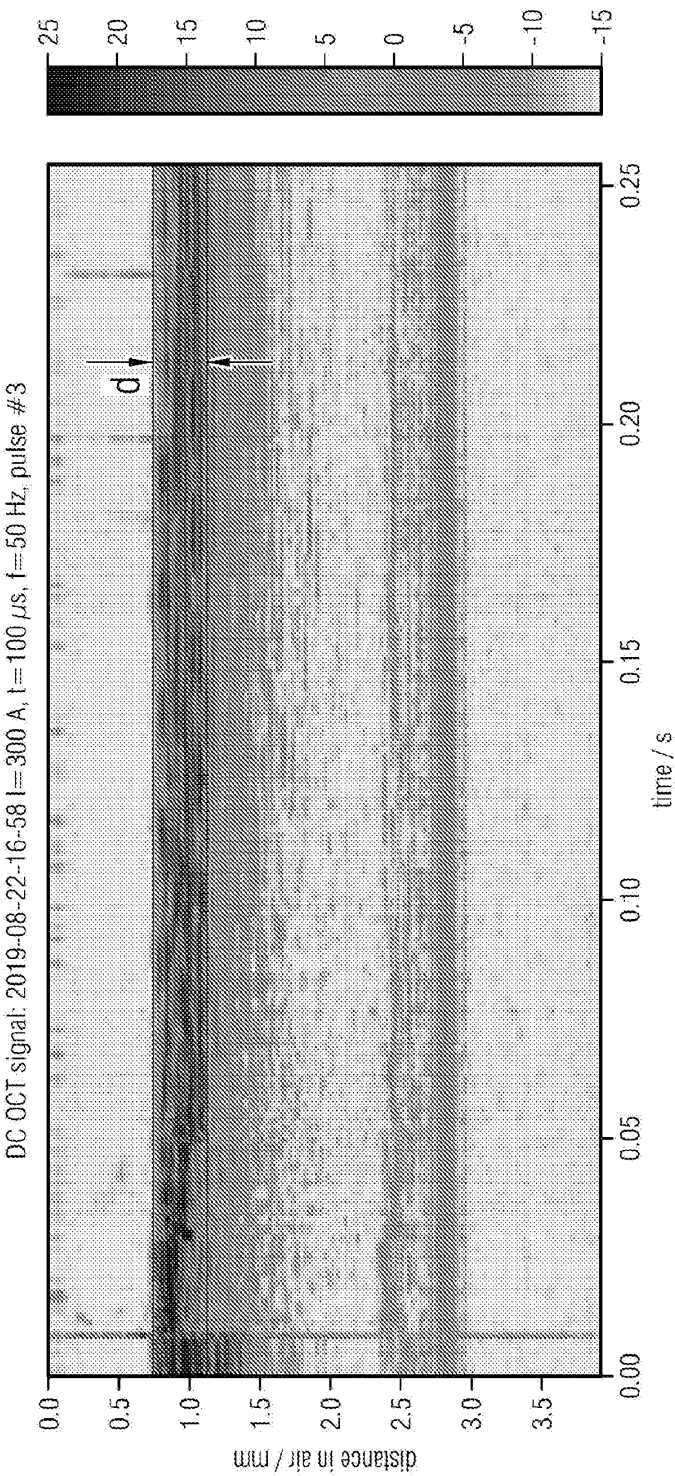


Fig. 34B: OCT Depth Control Signal with Porcine Eye:
3 pulses - d=0.36 mm: A-Scan (Unprocessed data)

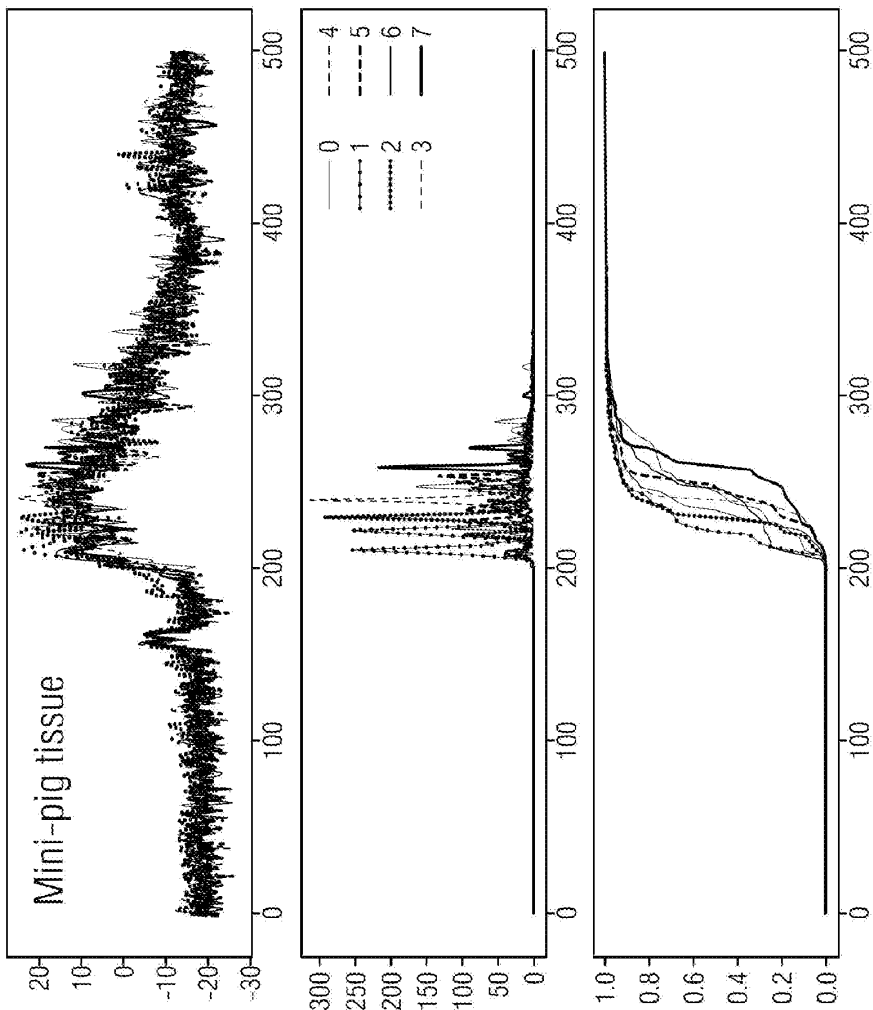


Fig. 35A: Depth Control Signal Analysis: Tissue from humans and other animals do not behave the same, an alternate algorithm must be used

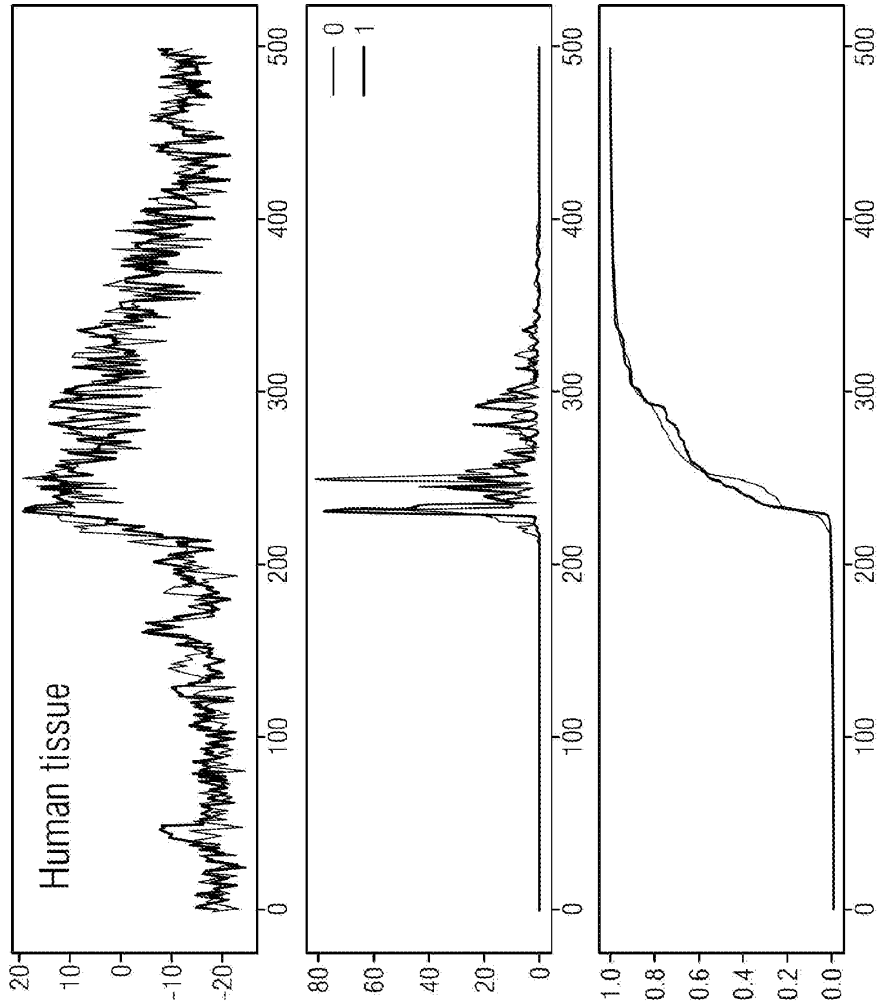


Fig. 35B: Depth Control Signal Analysis: Tissue from humans and other animals do not behave the same, an alternate algorithm must be used

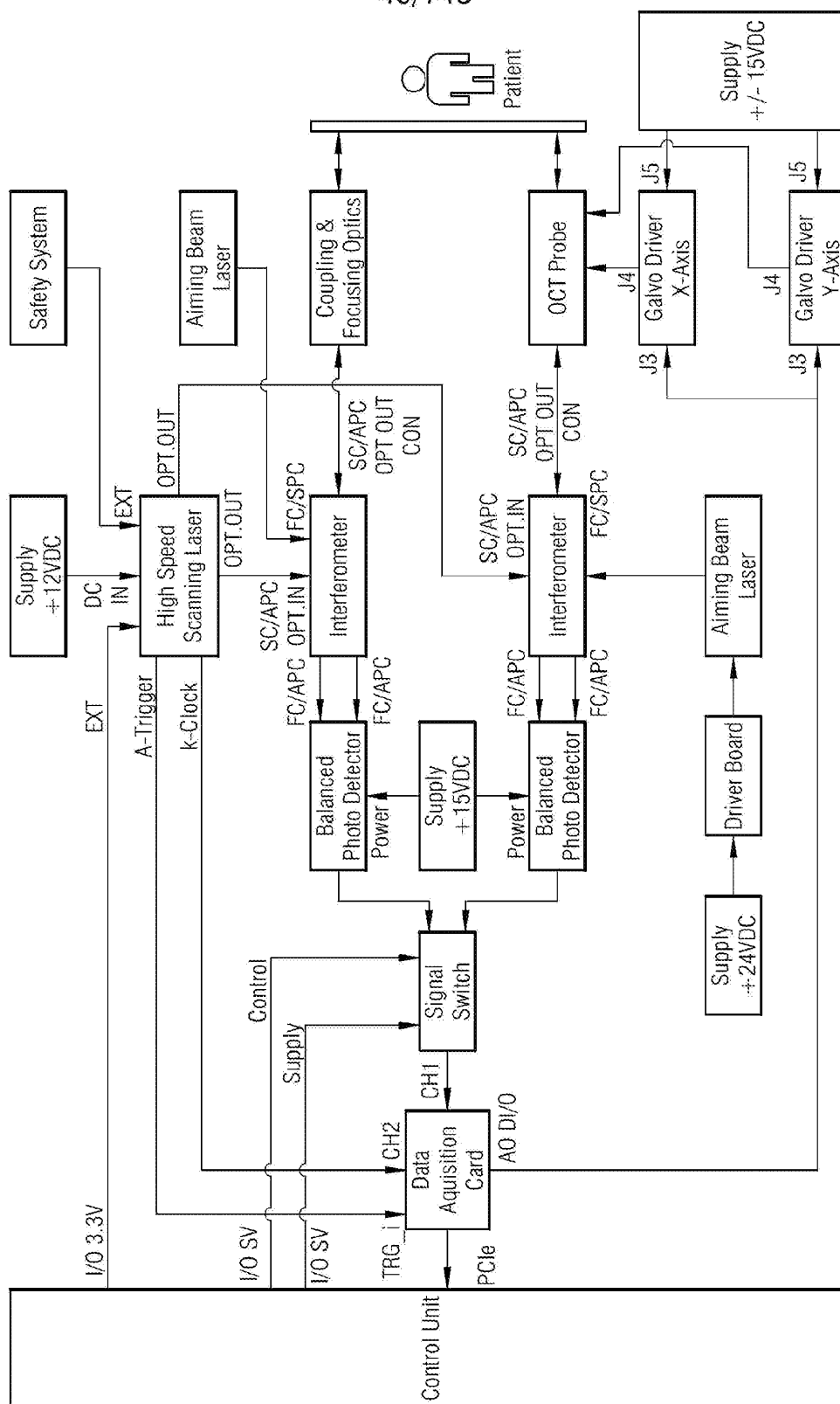


Fig 36: Control diagram of the Off-line (Dual) OCT Scanner

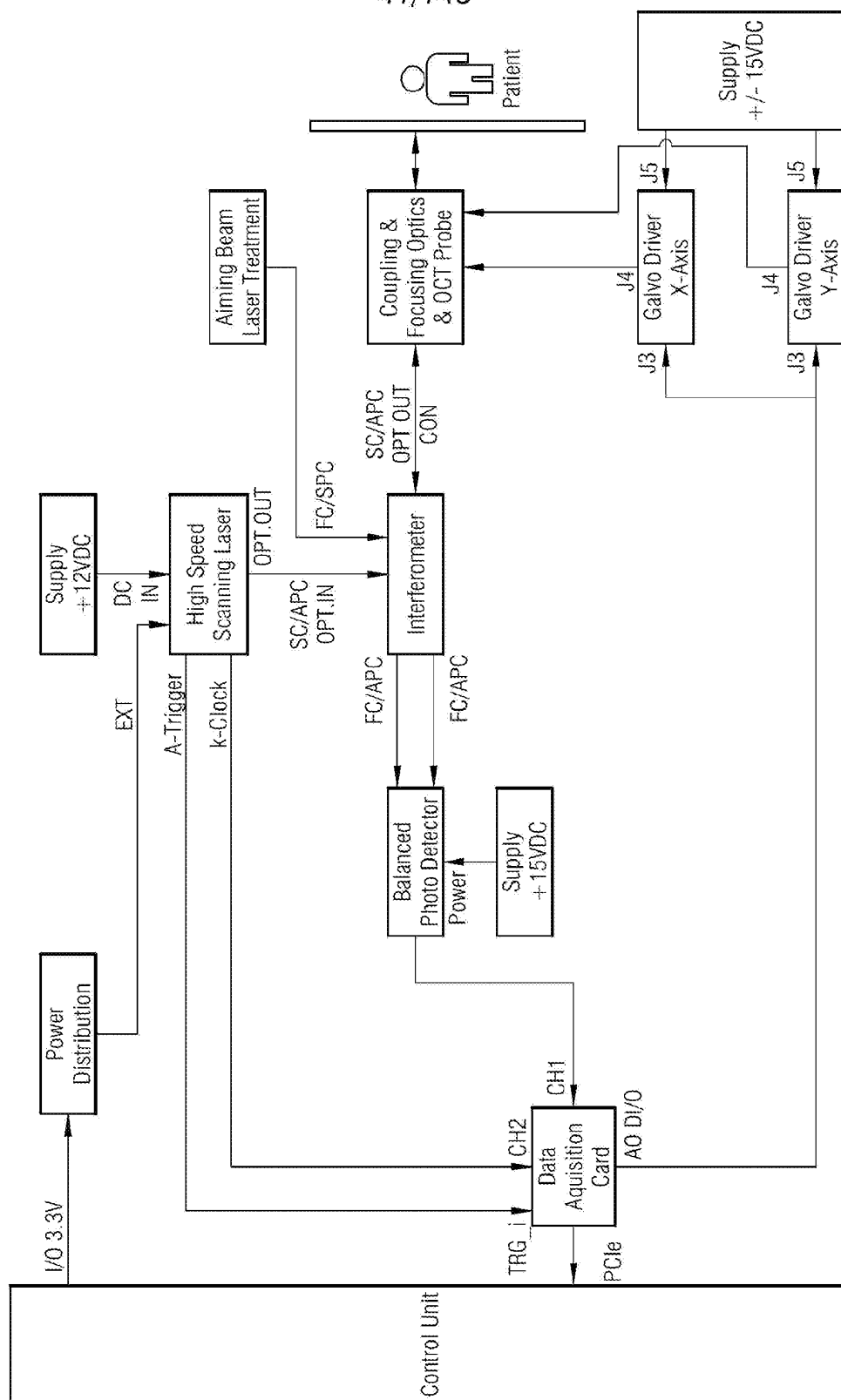


Fig. 37: OCT Architecture with Integratd Scanner

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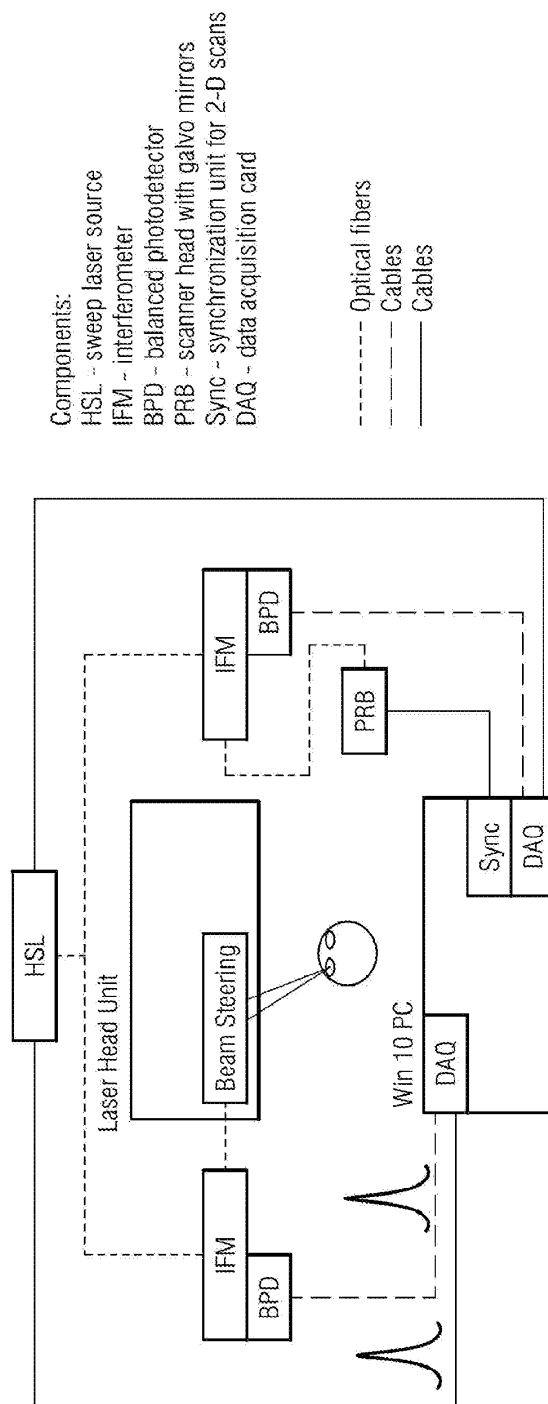


Fig. 38: Oct System Configuration for Depth Control and Laser ablation procedure

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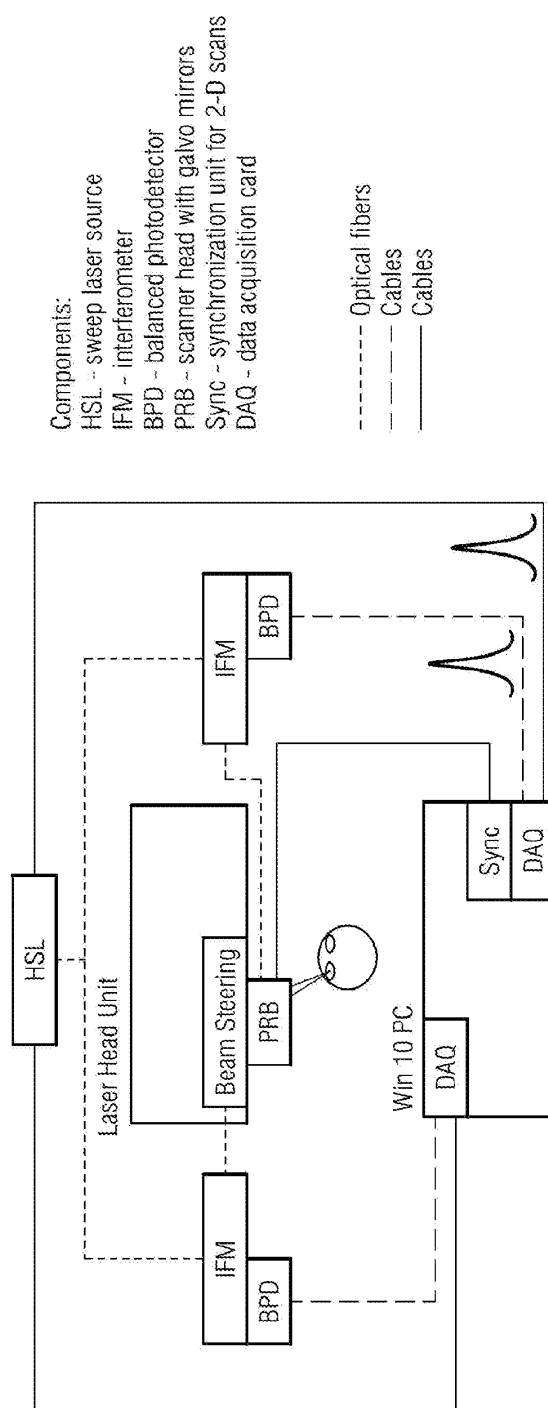


Fig. 39: OCT System Configuration for depth control and Laser ablation procedure that share dual purpose internal components, IFM and DAQ

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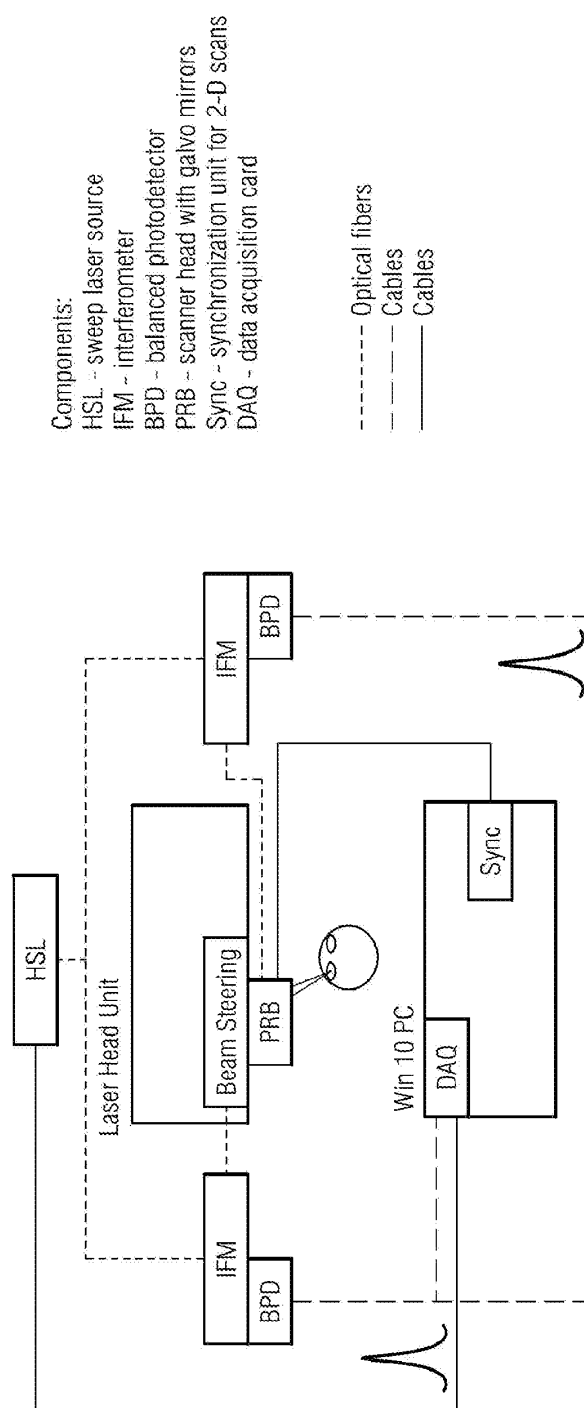


Fig. 40: OCT System Configuration for depth control and Laser ablation procedure with additional shared dual purpose internal components, IFM and DAQ

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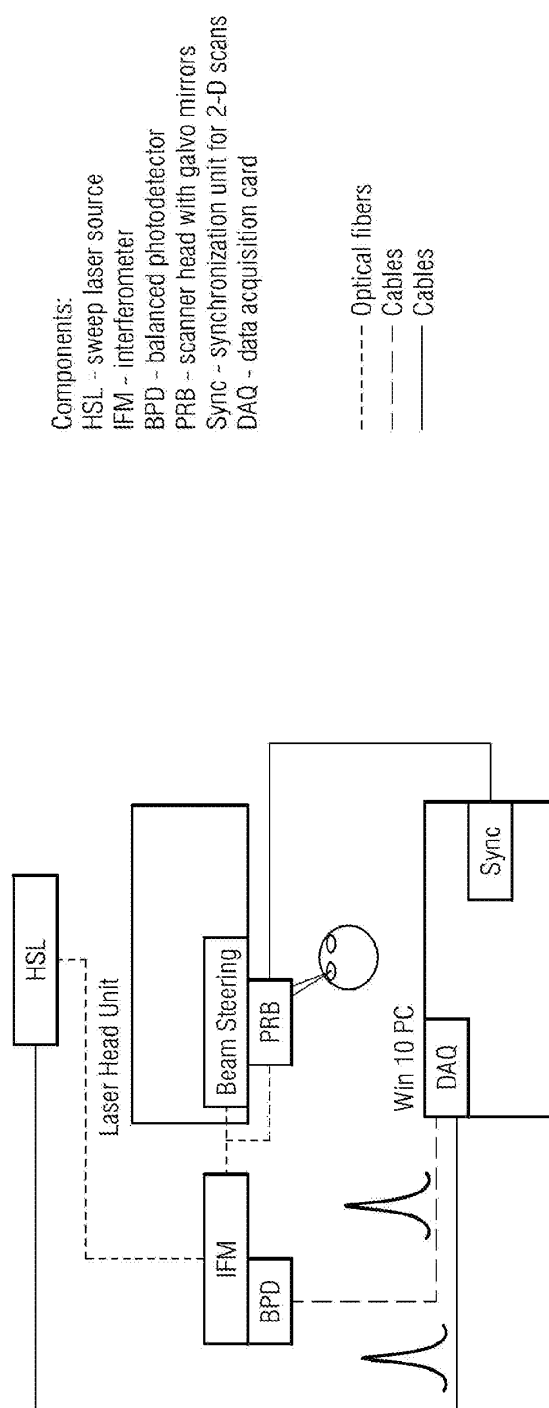


Fig. 41: OCT System Configuration for depth control and Laser ablation procedure with additional shared dual purpose internal components, IFM and DAQ

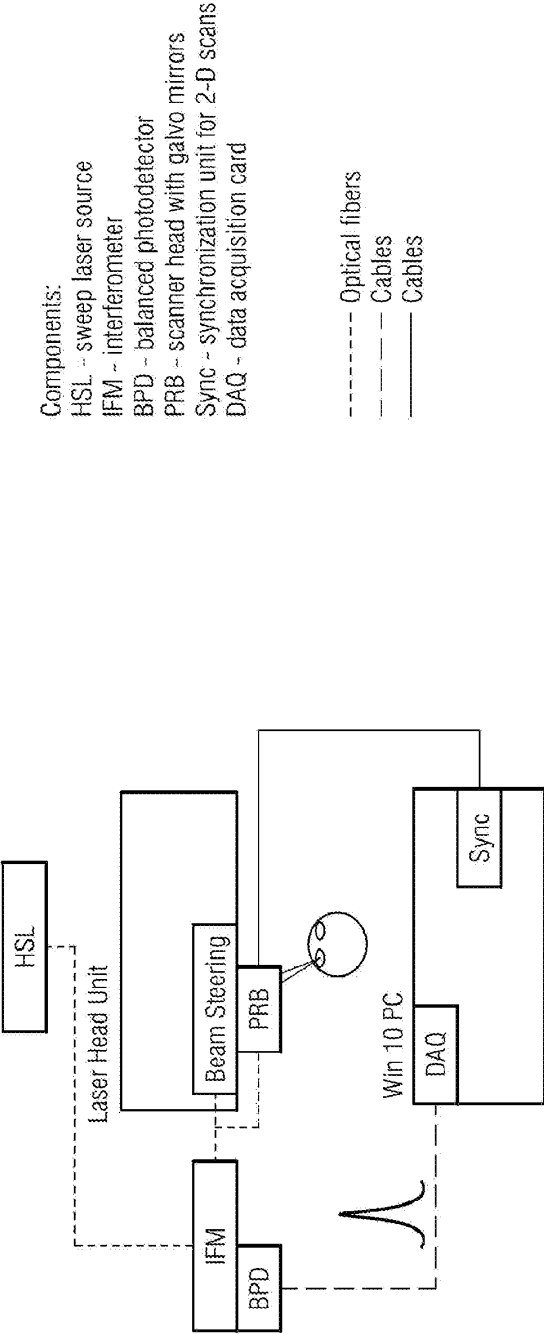


Fig. 42: OCT System Configuration for system with scanning mirror where OCT Depth Control and Scanning is done with the same OCT sensor and a scanning mirror

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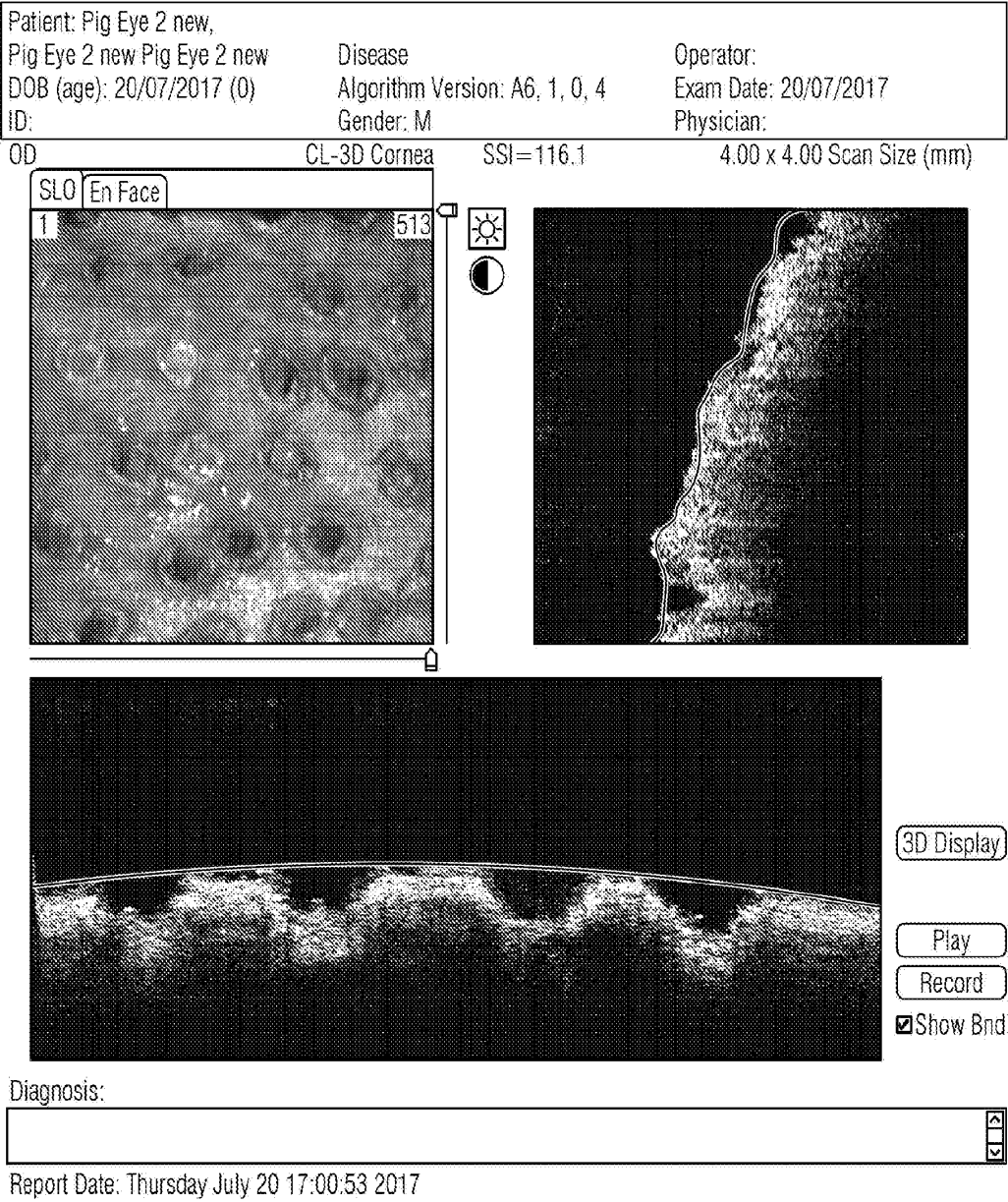


Fig. 43A: Scanning OCT image

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Patient: Pig Eye 2 new, Pig Eye 2 new Pig Eye 2 new DOB (age): 20/07/2017 (0) ID:	Disease Algorithm Version: A6, 1, 0, 4 Gender: M	Operator: Exam Date: 20/07/2017 Physician:
--	--	--

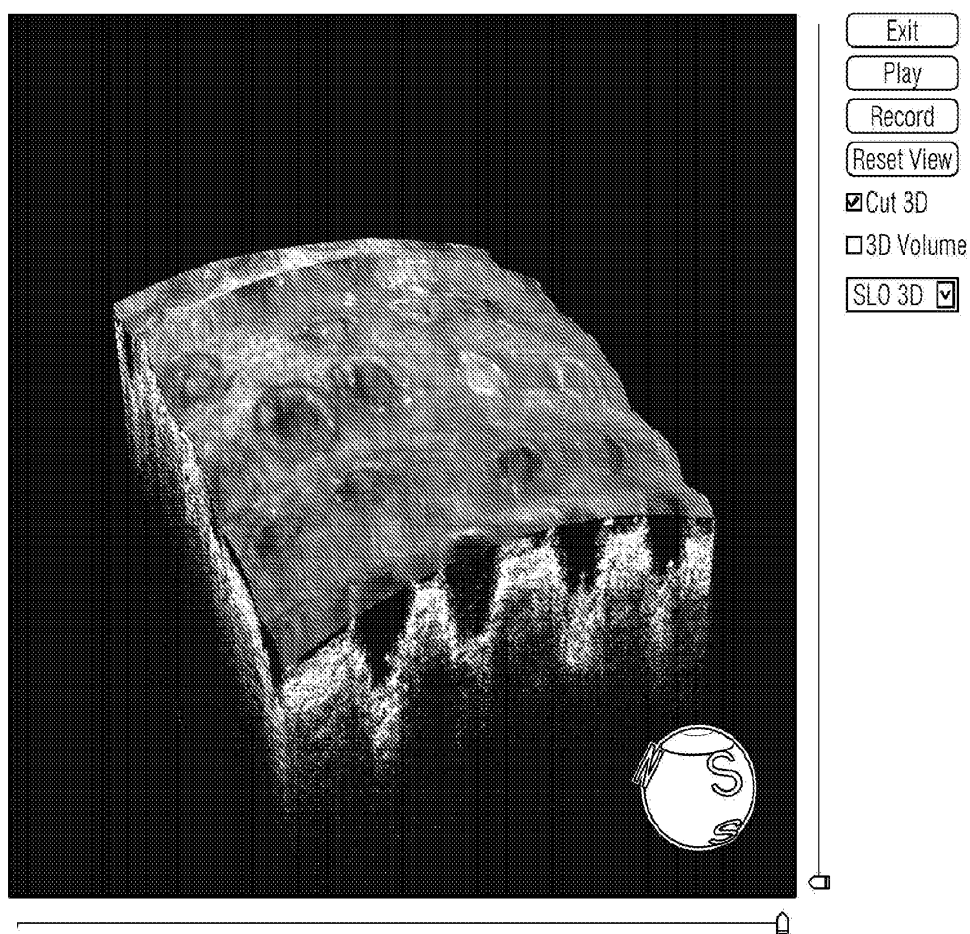
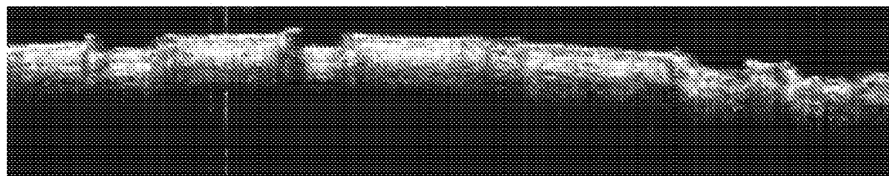


Fig. 43B: Scanning OCT image

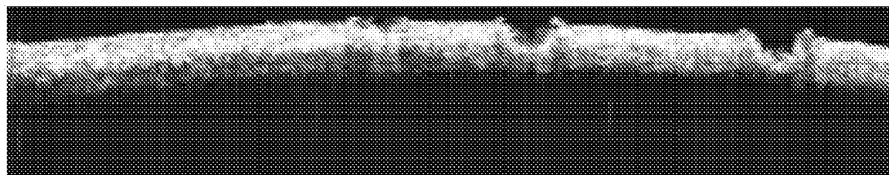
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A



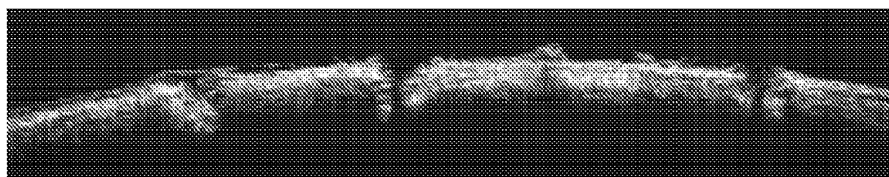
B



C



D



Evaluation of the depth of laser ablation by ASOCT.
The margin of the scleral micropores was clearly visible.

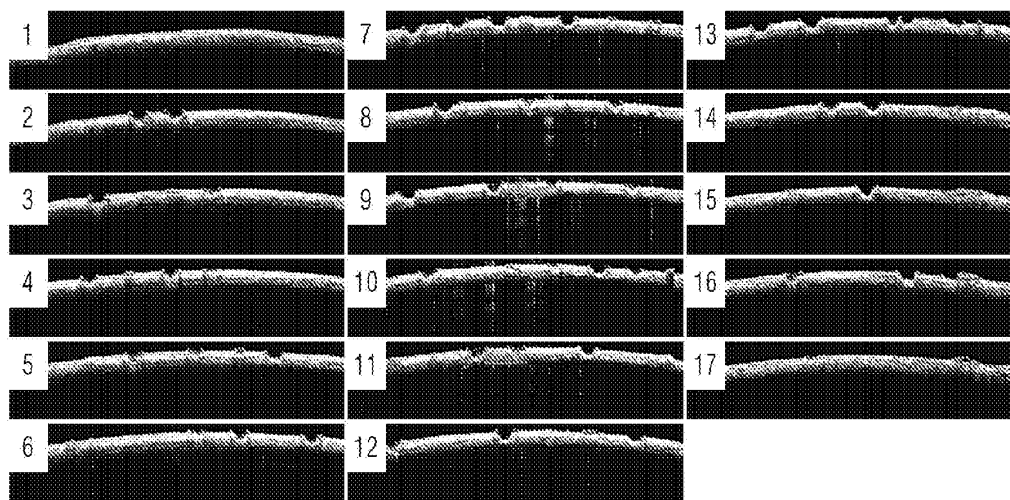
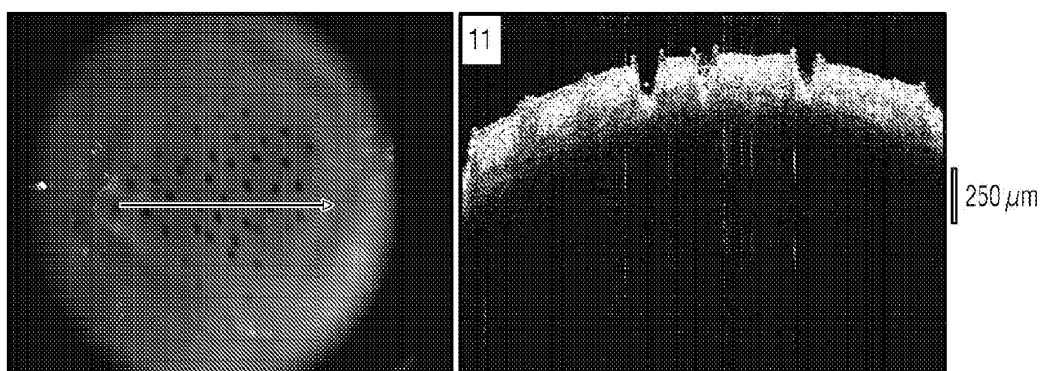
Fig. 44: OCT of Micropores

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Patient: Pig Eye 2 new, Pig Eye 2 new Pig Eye 2 new DOB (age): 20/07/2017 (0) ID:	Disease Algorithm Version: A6, 1, 0, 4 Gender: M	Operator: Exam Date: 20/07/2017 Physician:
--	--	--

OD CL-Raster SSI=134.1 6.90mm x 5.50mm Scan Size

Display
☒ 1 page ☐ 2 pages



Diagnosis:

Report Date: Thursday July 20 16:57:55 2017

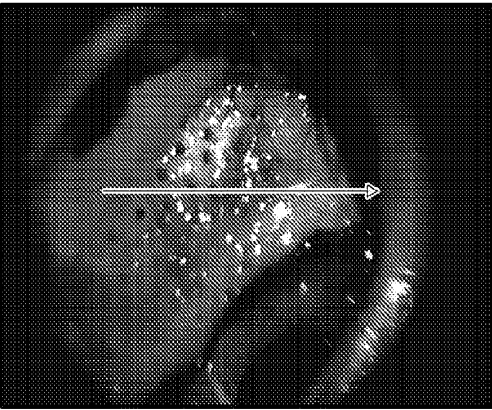
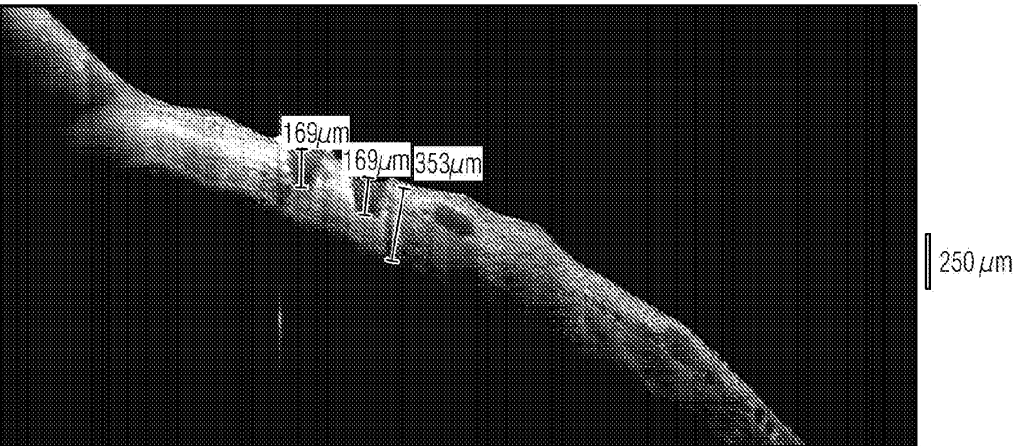
Treatment protocol:
8ppp @ 10% density;
5x5 array
Average Thickness Sclera: 400um
Average Depth of Micropore: 185um
Depth Ratio: 46%

Fig. 45: OCT Depth Measurement

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Patient: Monkey 5246, PLEASE LASER OD 7ppp, OS 8ppp Disease		Operator:
DOB (age): 21-07-2017 (0)	Algorithm Version: A6, 1, 0, 4	Exam Date: 20/07/2017
ID:	Gender: M	Physician:
OS	CL-Line	SSI=82.2
8.00mm Scan Length		



of Averages: 32

Diagnosis:

Report Date: Tuesday August 01 13:57:29 2017

Fig. 46: OCT images showing depth of Micropores

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Eye Tracking system capable of:

- the pupil, iris, vessels and sclera detection DNN Network
- Feature tracking with focus on features in the iris and pupil only
- Automatic detection of eye-centers with TOF and automatic zoom on eye to be treated by Moveable Mirror

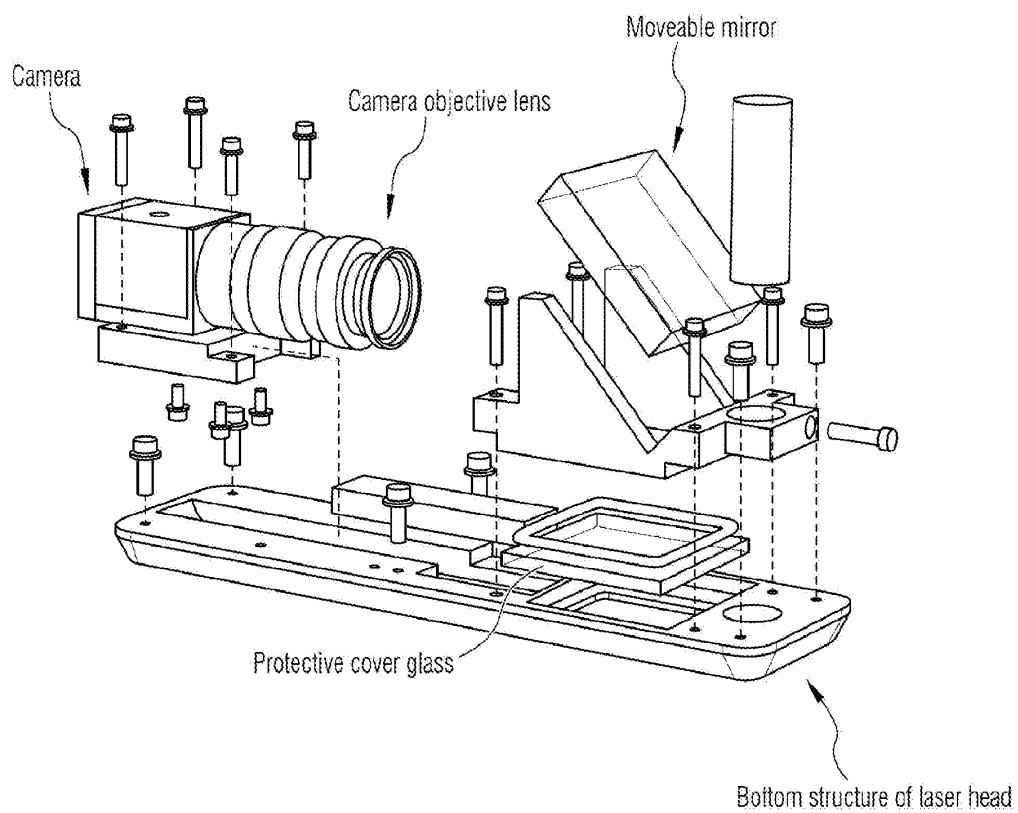


Fig. 47: Eye tracking architecture

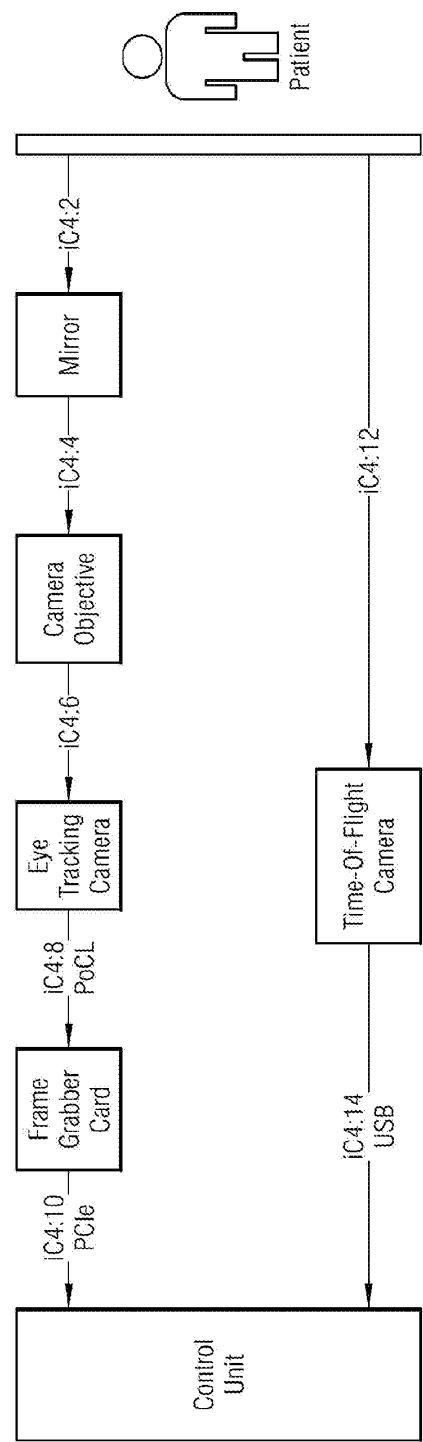


Fig. 48: Eye tracking process diagram

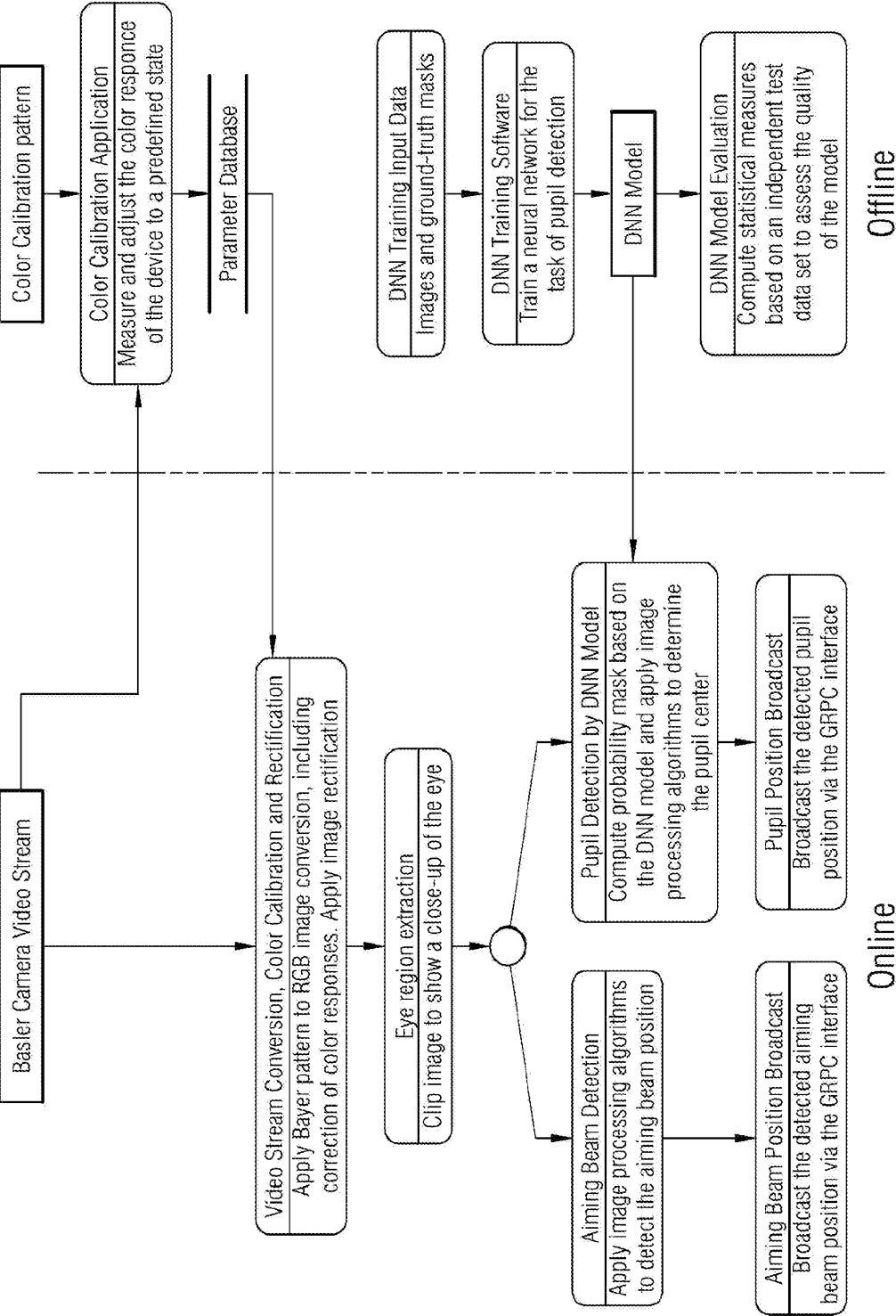


Fig. 49: Eye tracking process diagram

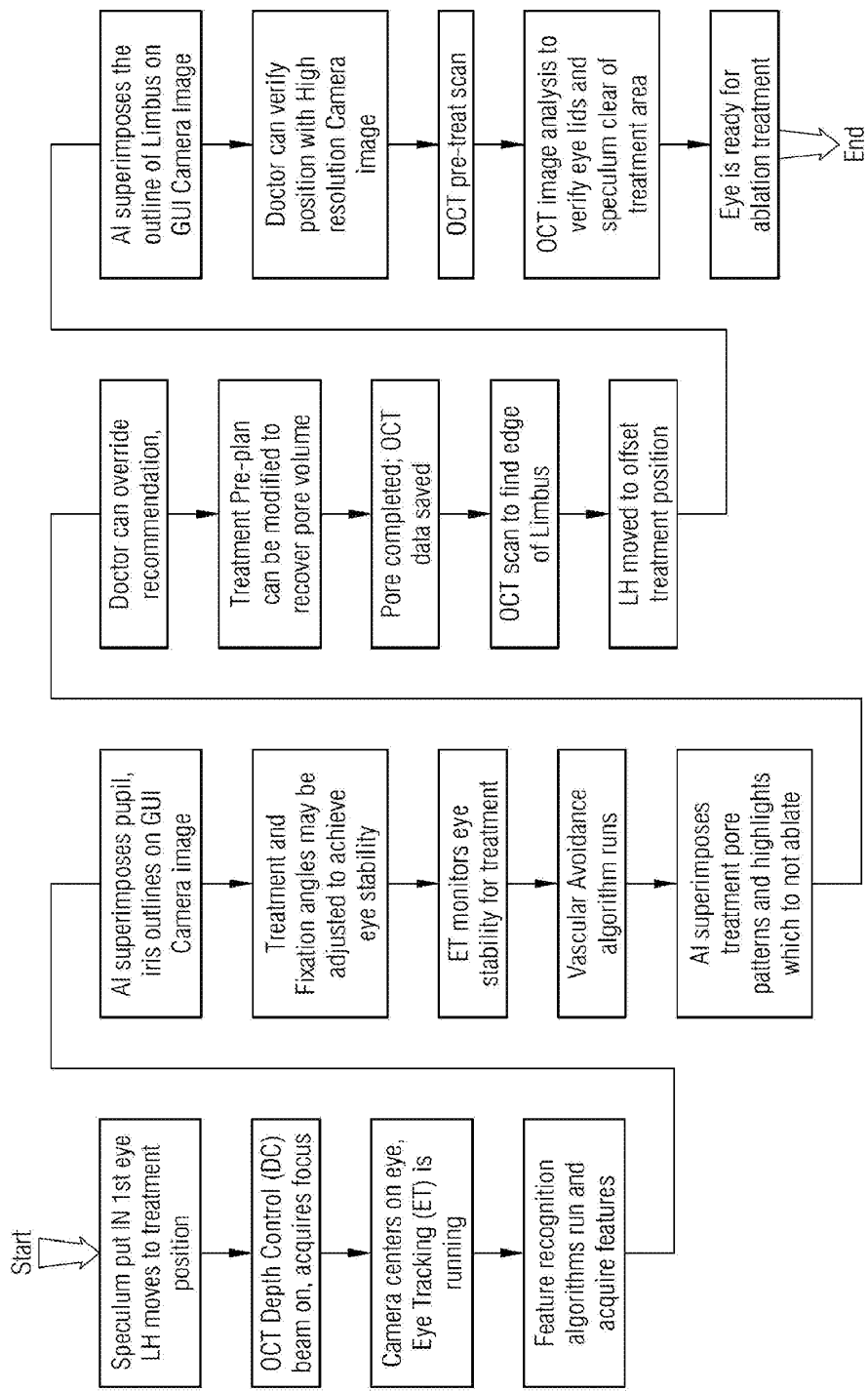


Fig. 50: Method for Feature Recognition and Treatment Position alignment to AT Limbus

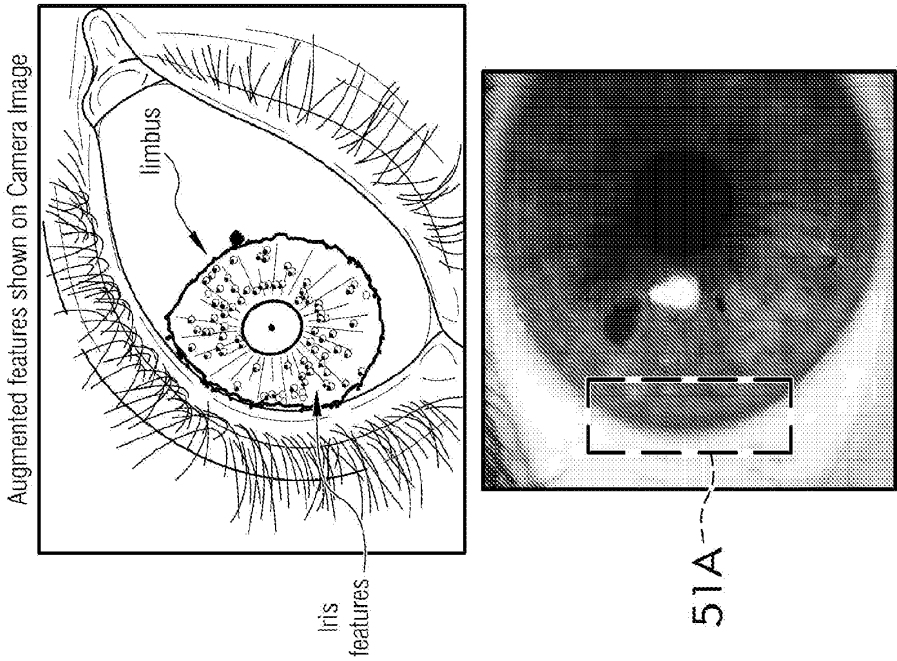


Fig. 51: Feature recognition of the AT limbus highlighted through AI analysis and shown as an overlay to the camera image

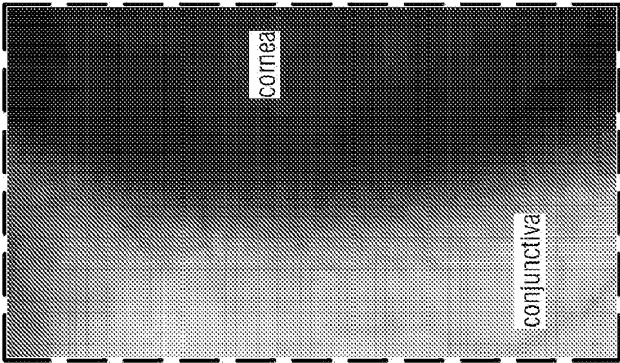


Fig. 51A

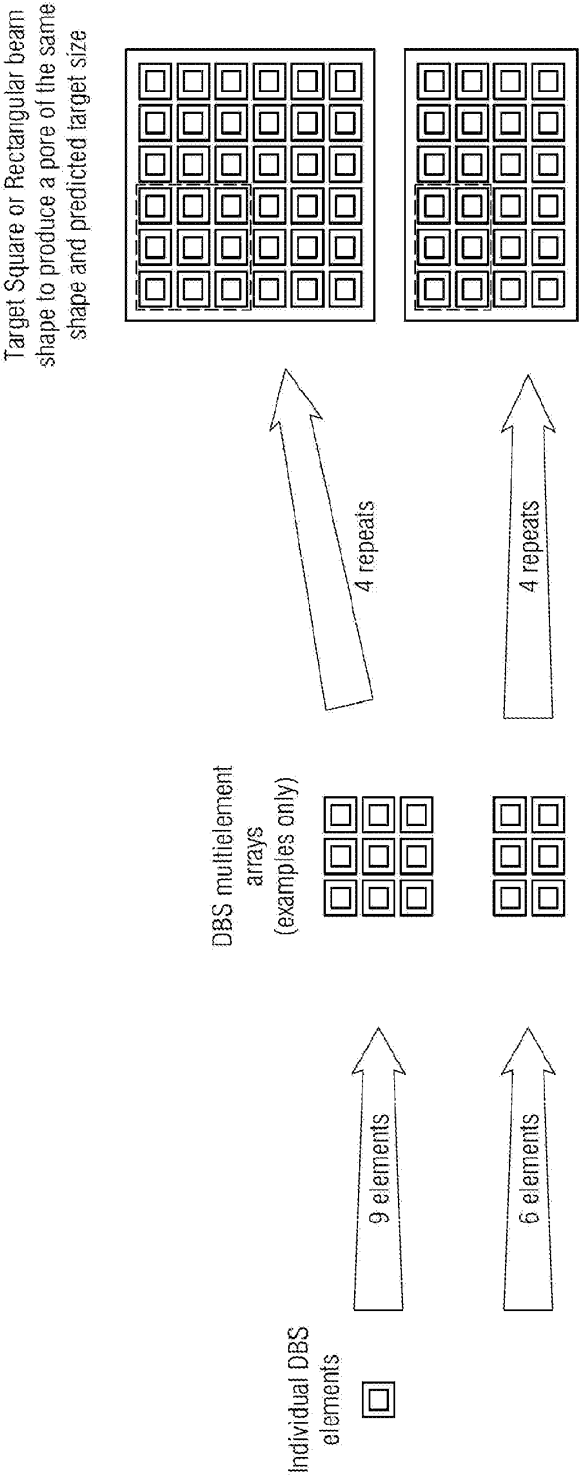
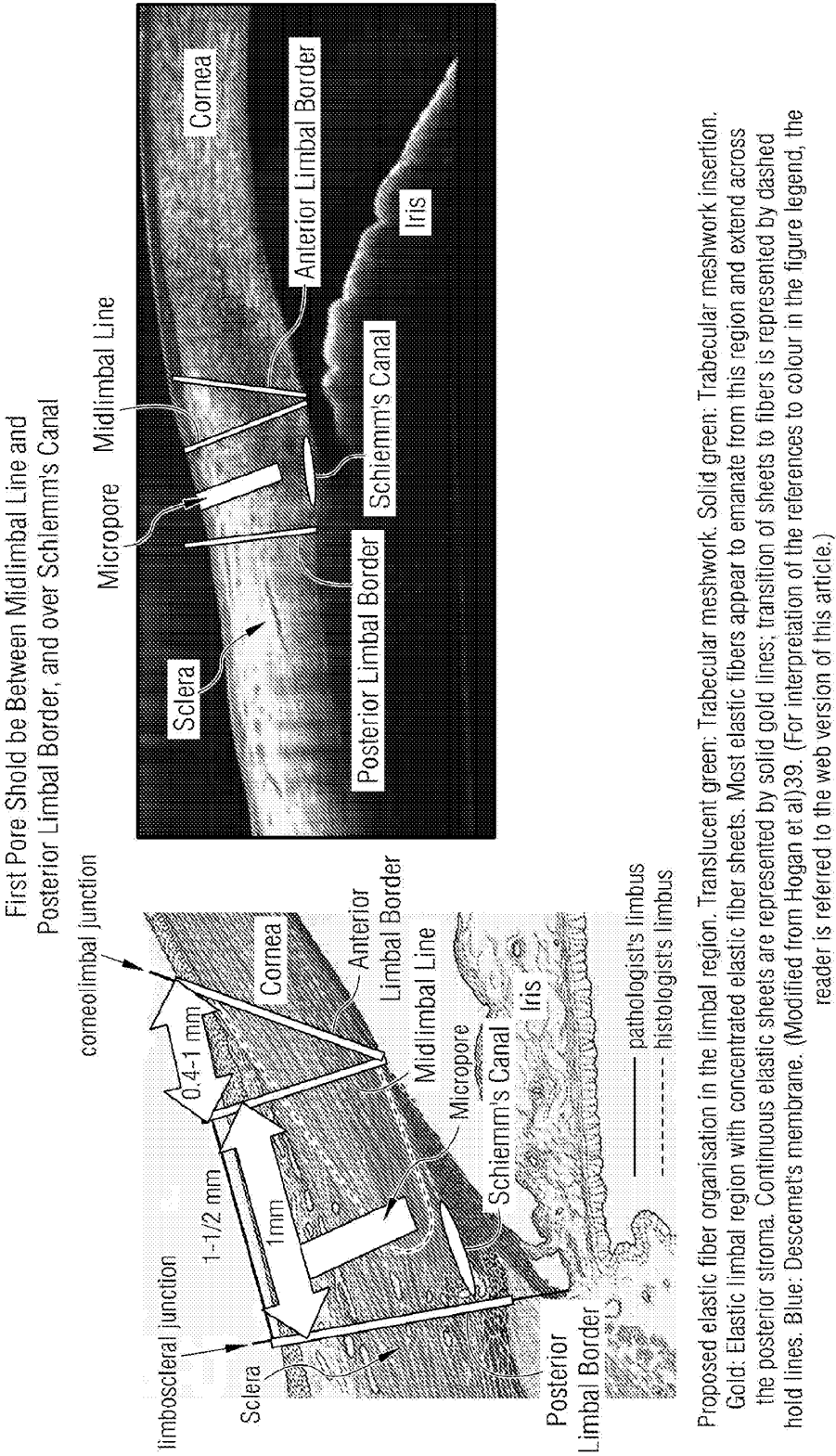


Fig. 52: Design Concept to create a plurality or size and shaped pores through multiple exposures using a DBS



Retina

Fig. 53: Treatment Positioning relative to Anatomical Limbus

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OCT/ DC A-scan from the cornea over sclera shows
Schlemm's Canal and the edge of the Limbus

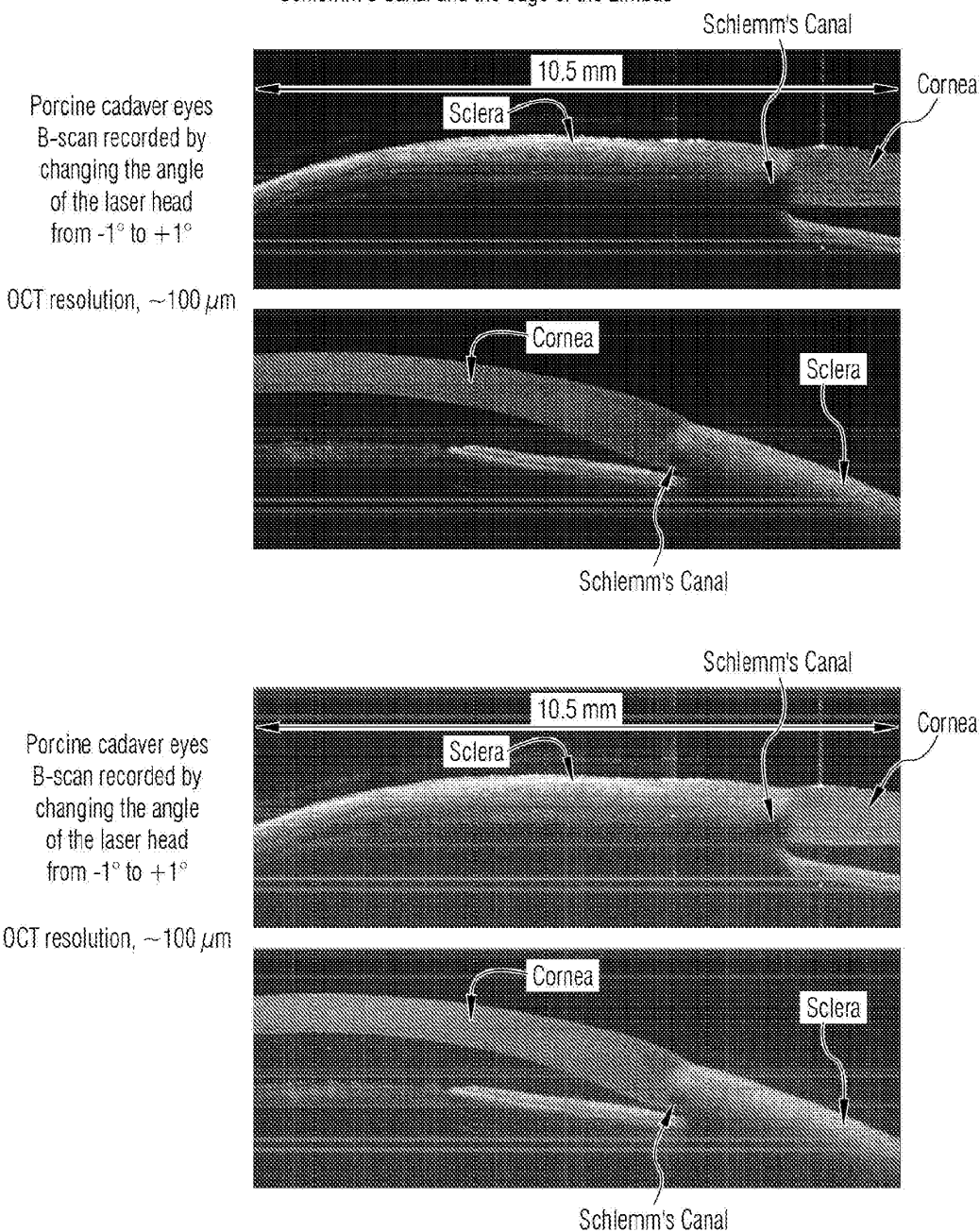


Fig. 54: OCT/ DC A-scan from the cornea over sclera shows Schlemm's Canal and the edge of the Limbus at 2 resolutions

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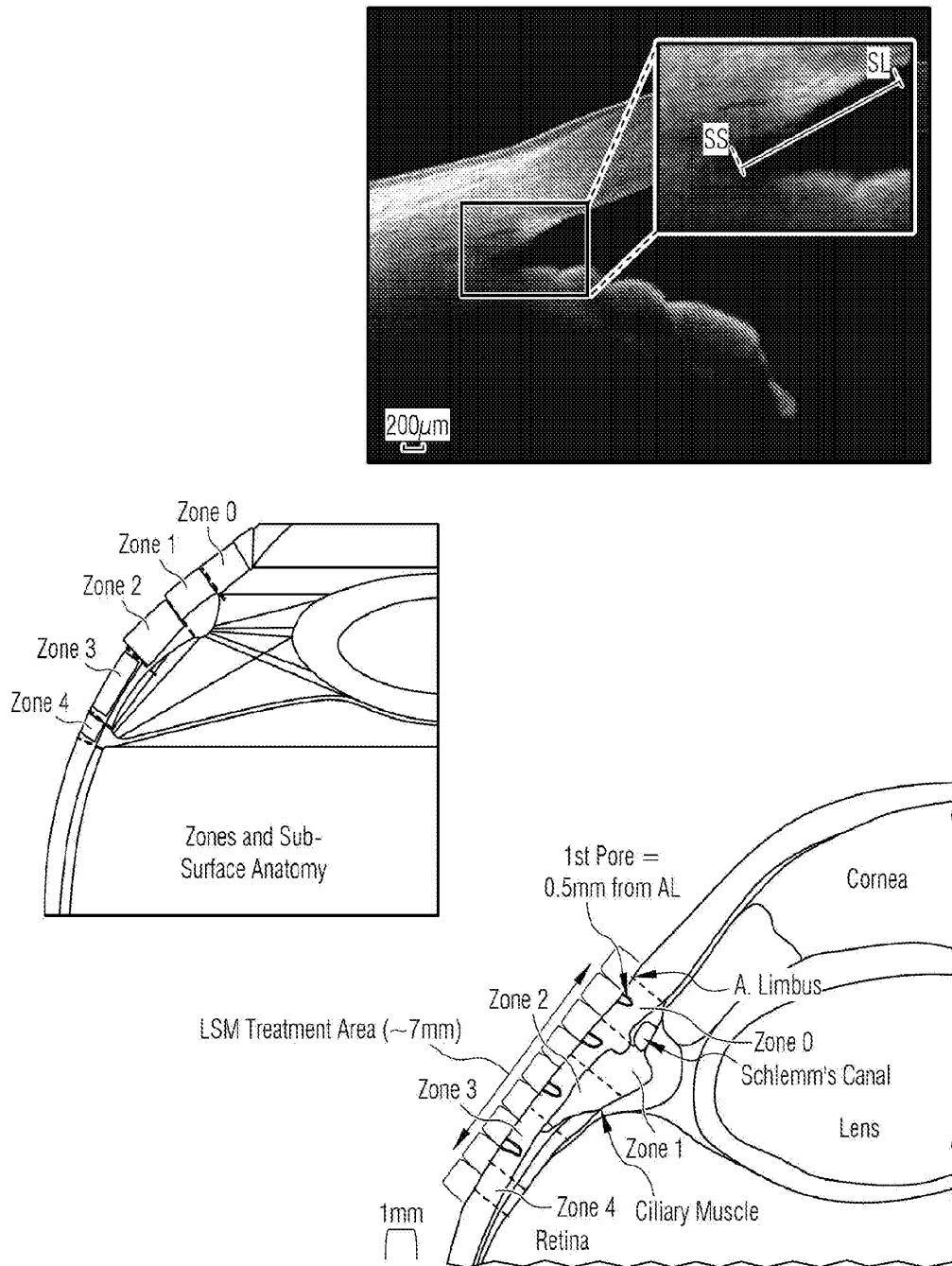


Fig. 55: Treatment position relative to Schlemm's Canal and Anatomical limbus

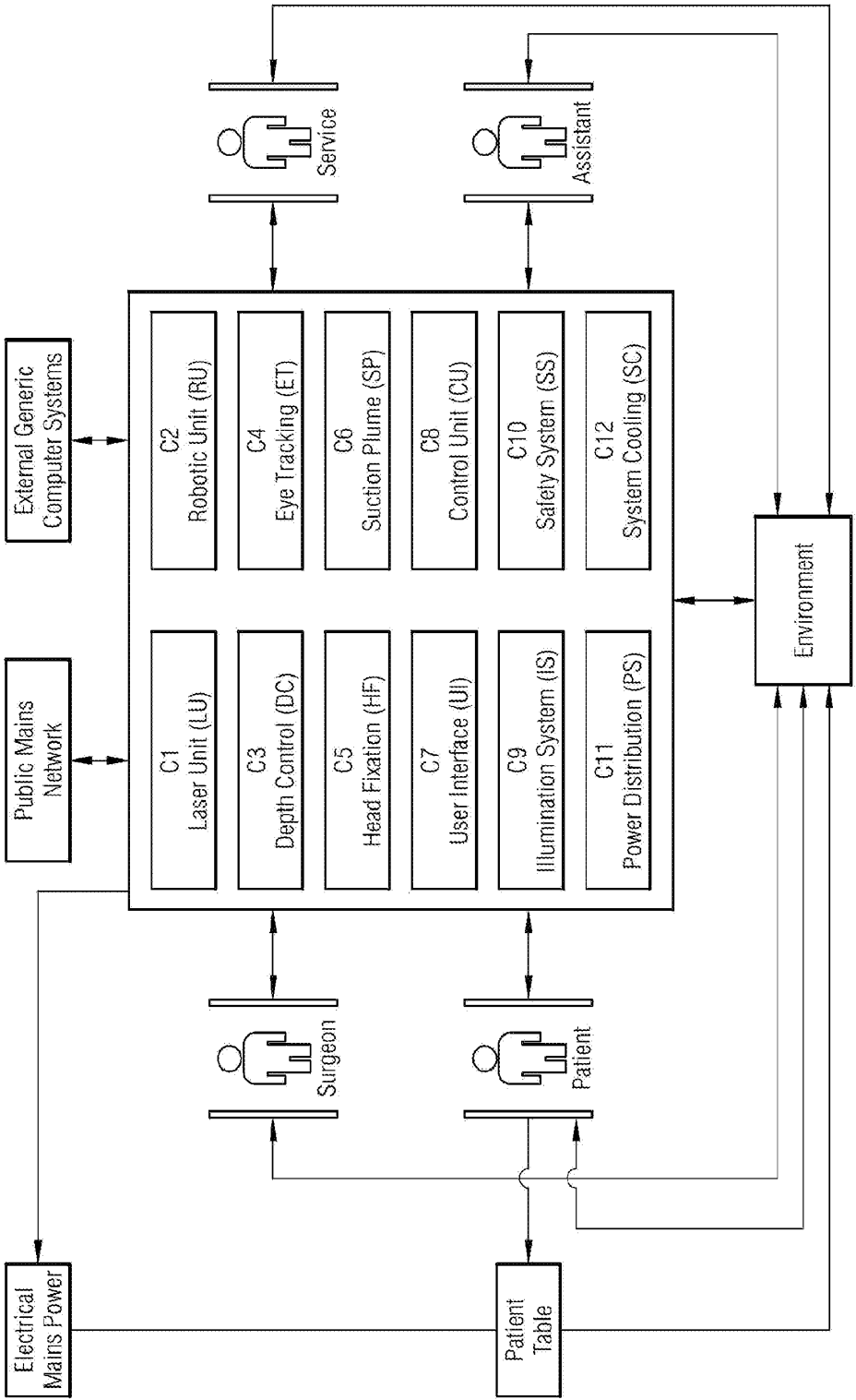


Figure 56: User / System architecture diagram

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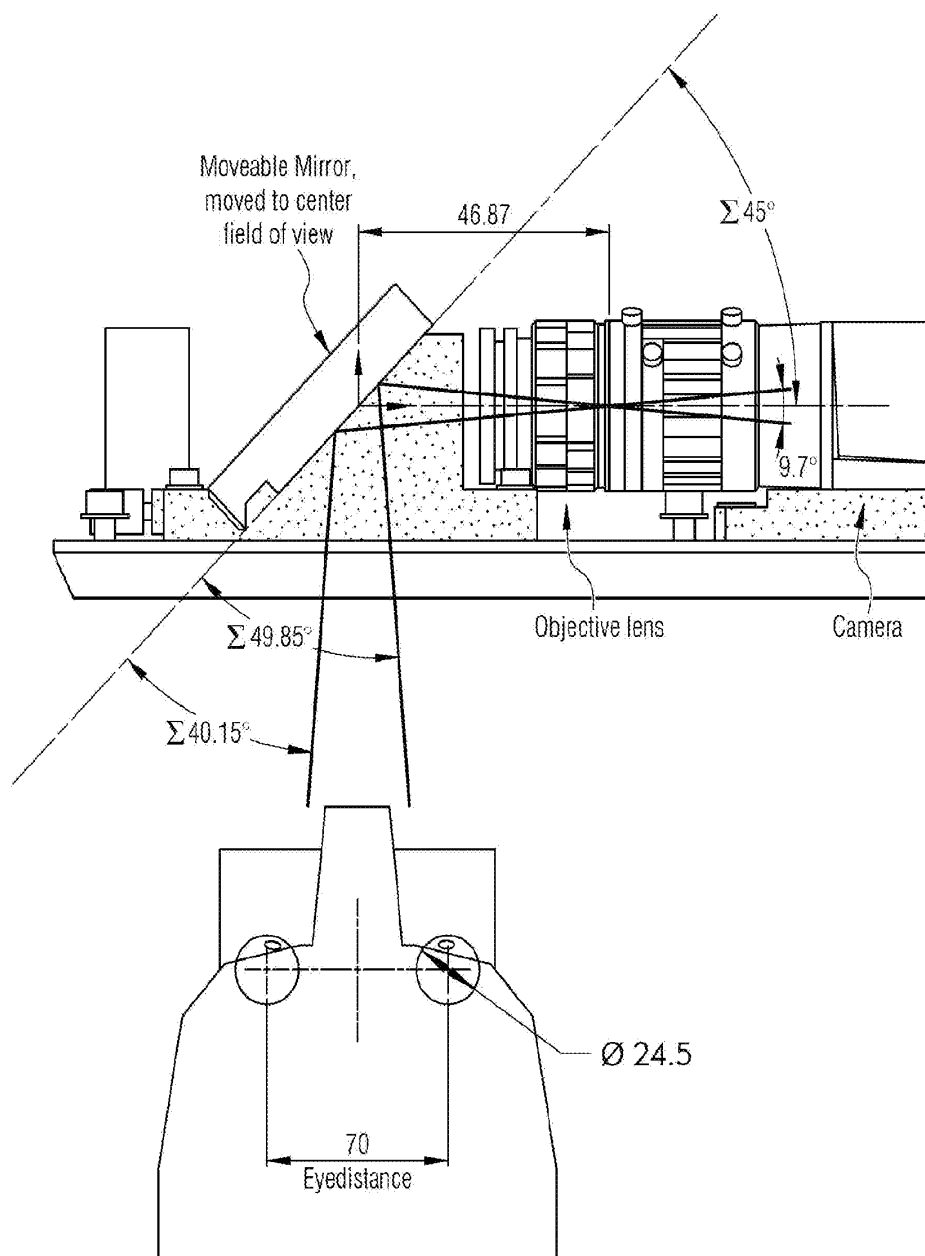


Fig. 57: High Magnification Camera System with mirror

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Magnification factor = 0.4 x-2.4 x
Zoom ratio 1 : 6
Resolution: 1,680 x 1,050

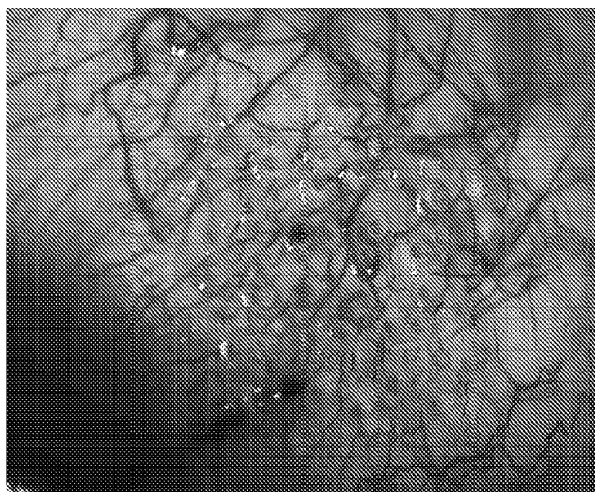
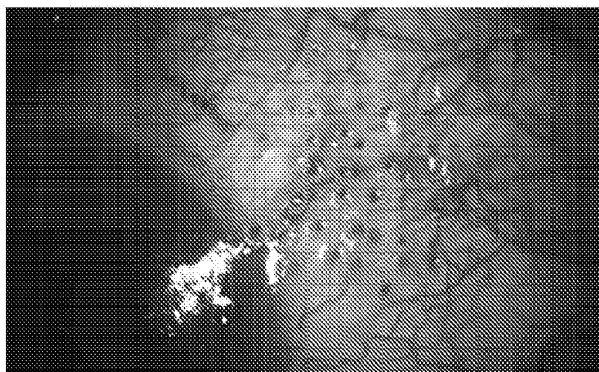


Fig. 58: Microscope quality camera images at a higher magnification and resolution for inspecting treatment area and manual treatment positioning

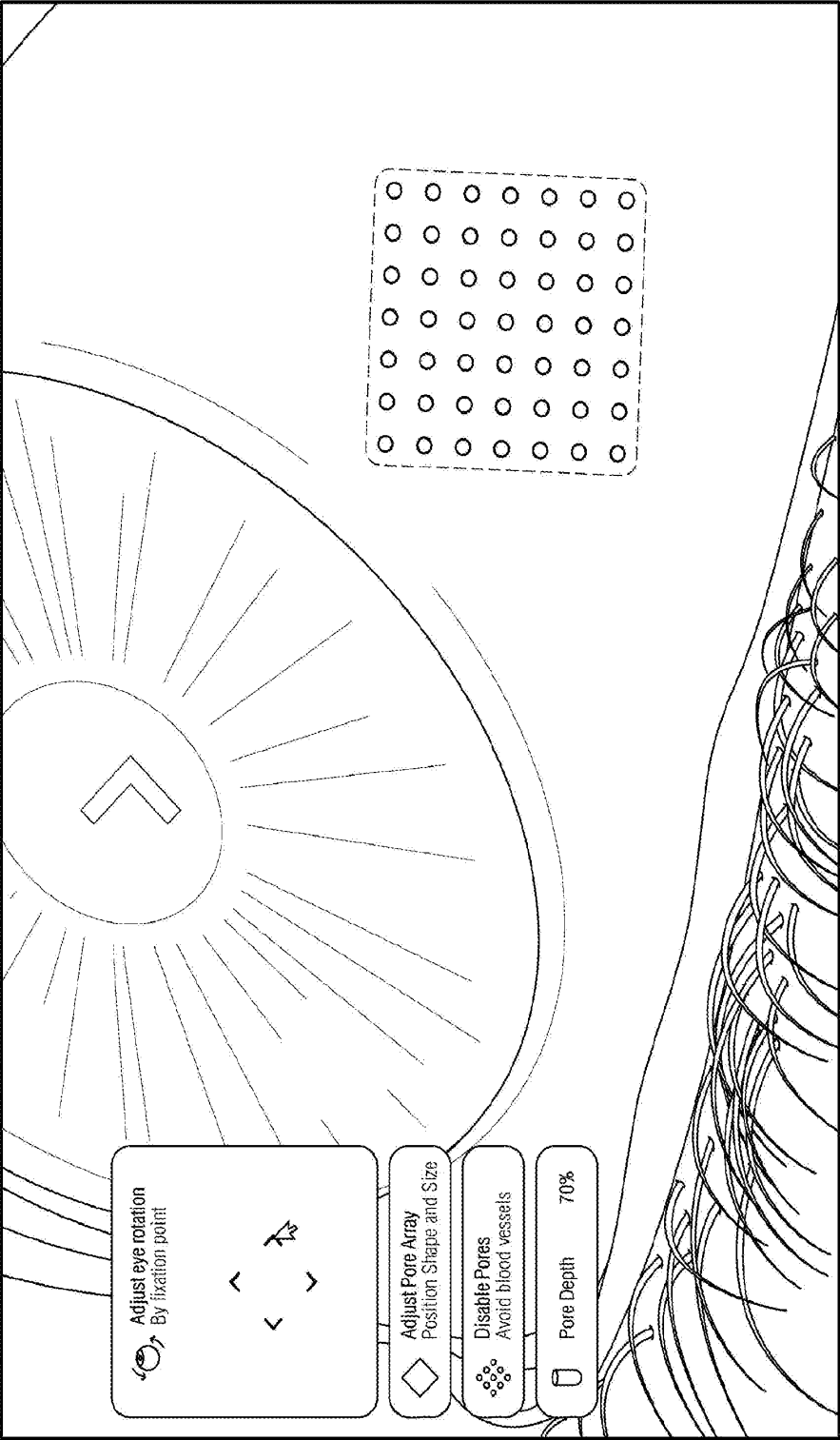


Fig. 59

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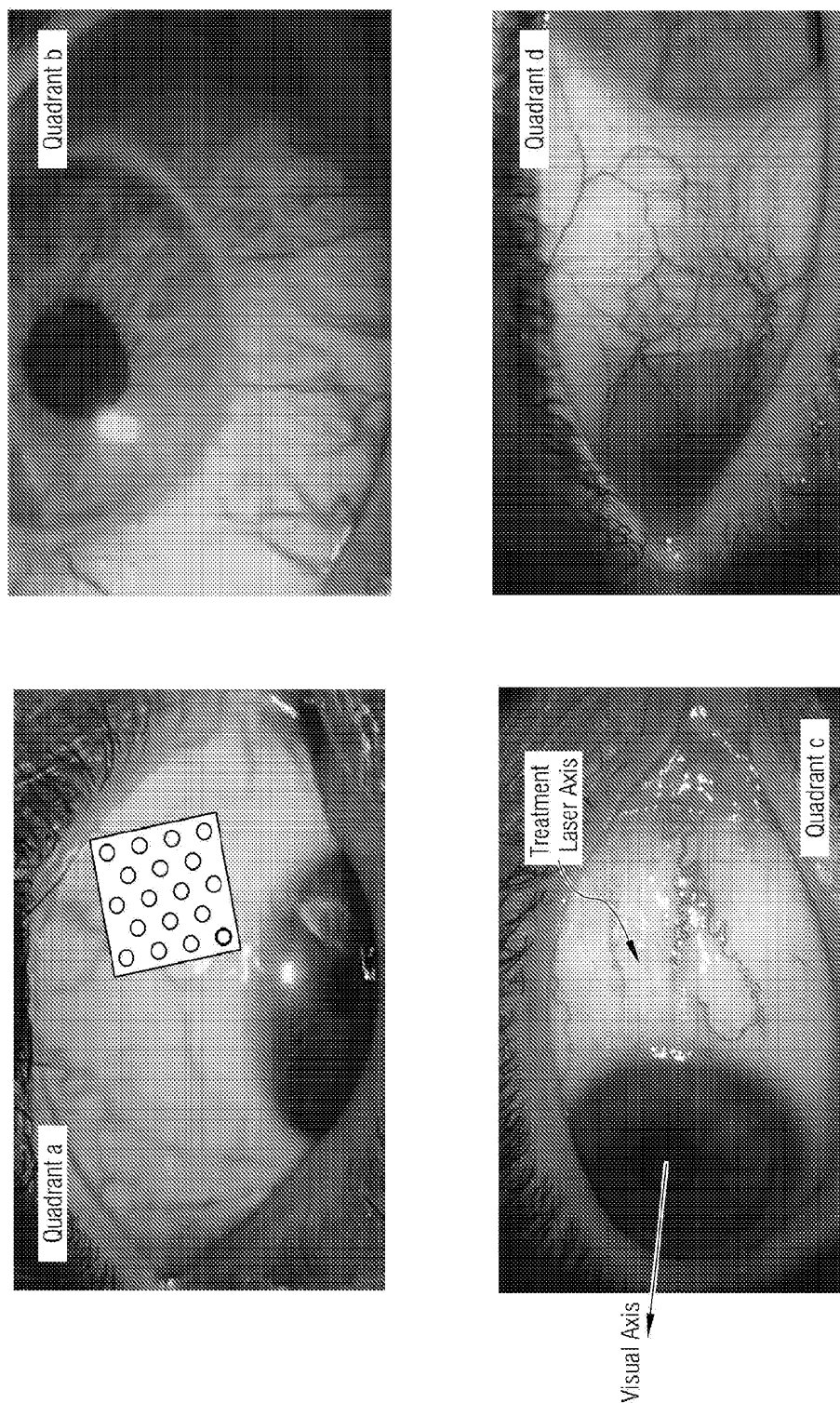


Fig. 60: Extreme eye movements by Off-Axis Scanning laser, beam
NOT coincident with the visual axis or the pupil

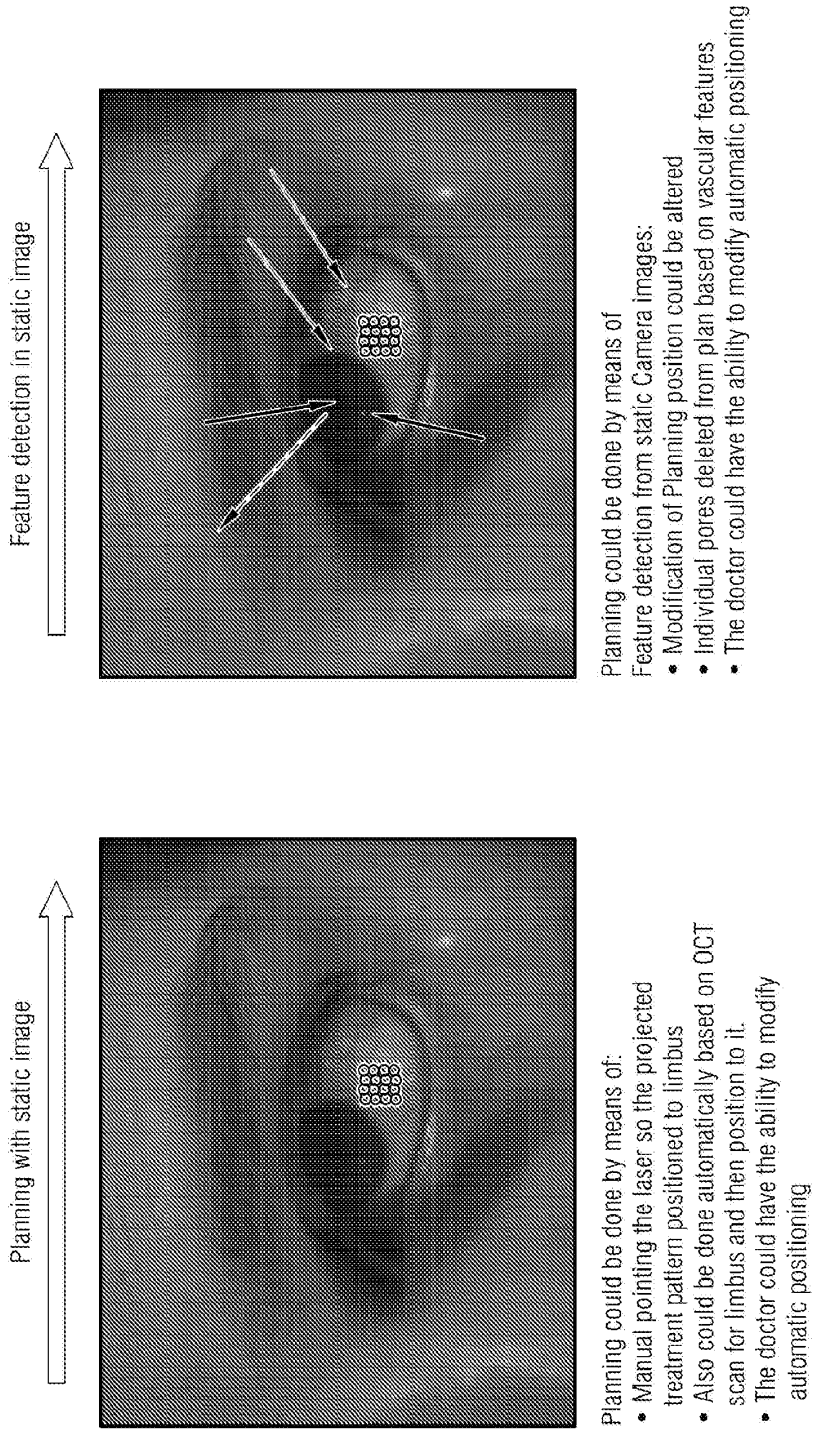


Fig. 61A: Methods for Treatment Positioning and Anatomy Avoidance

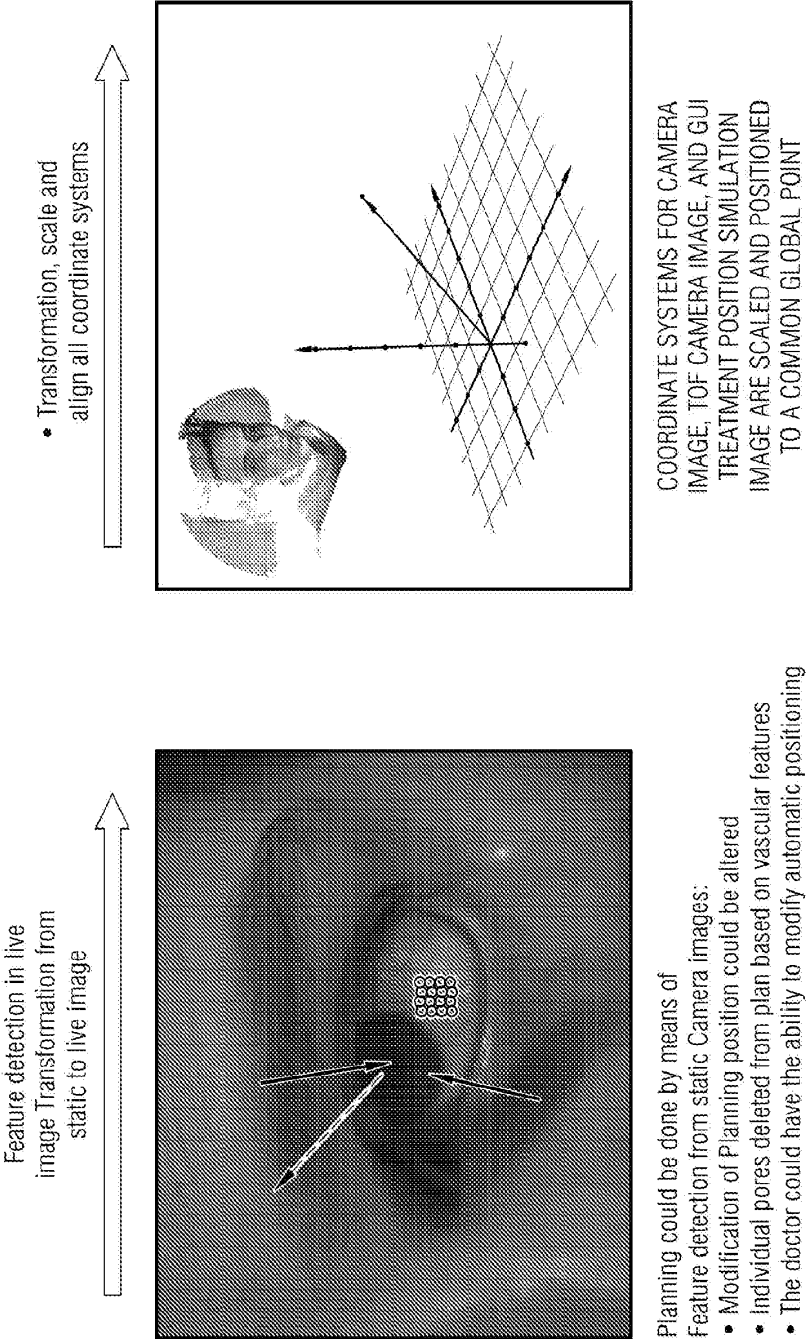


Fig. 61B: Methods for Treatment Positioning and Anatomy Avoidance

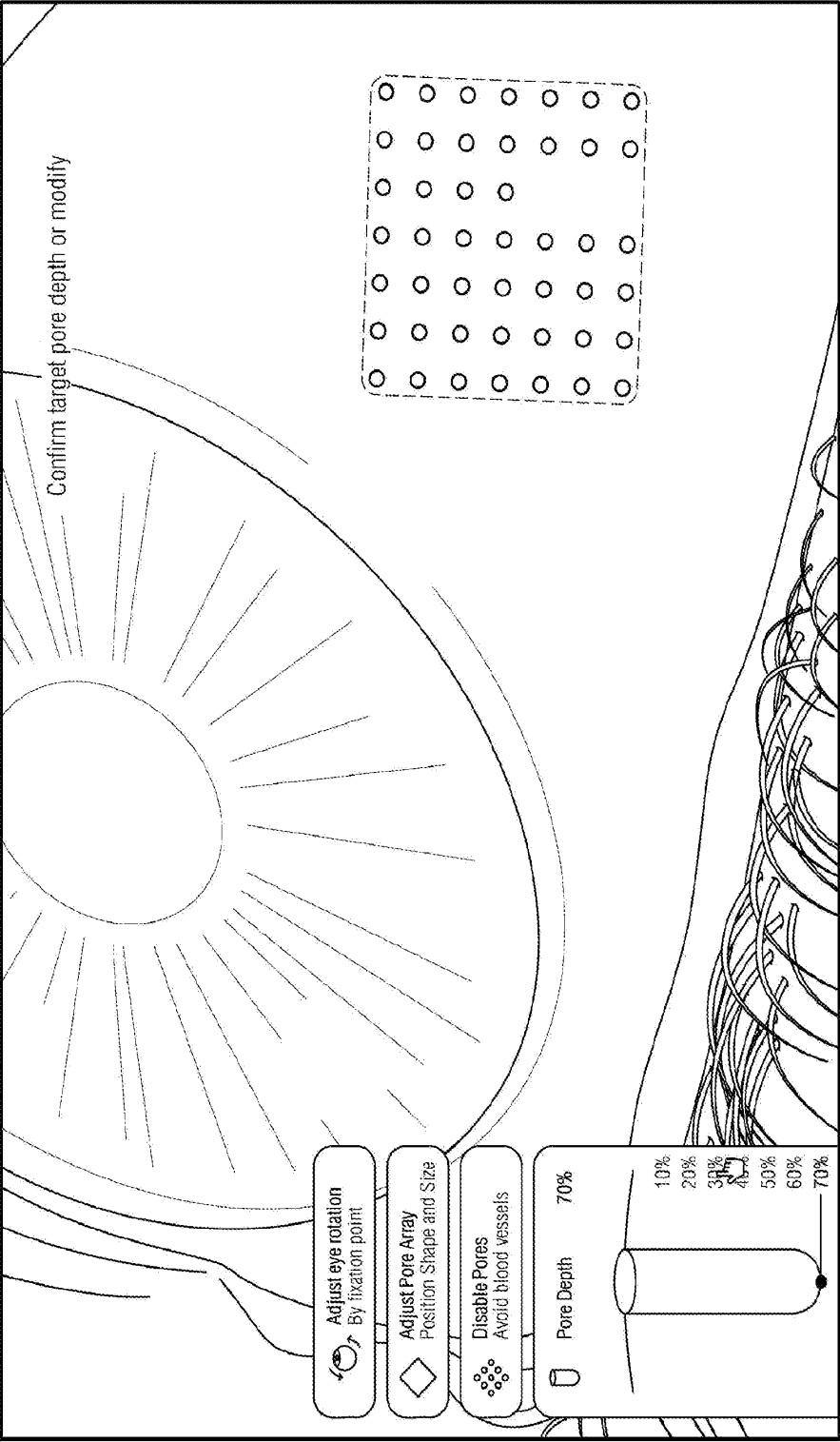


Fig. 62

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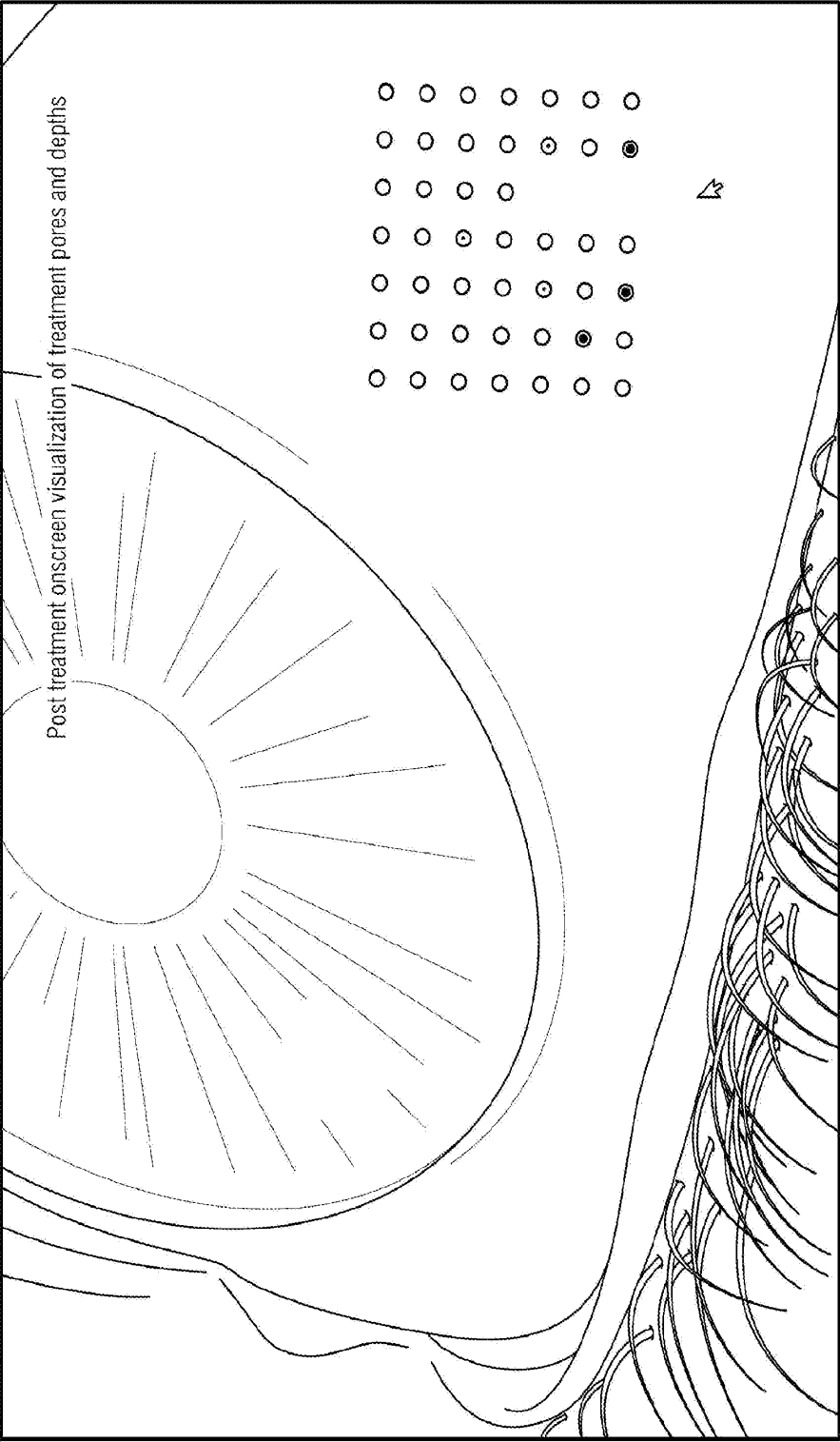


Fig. 63

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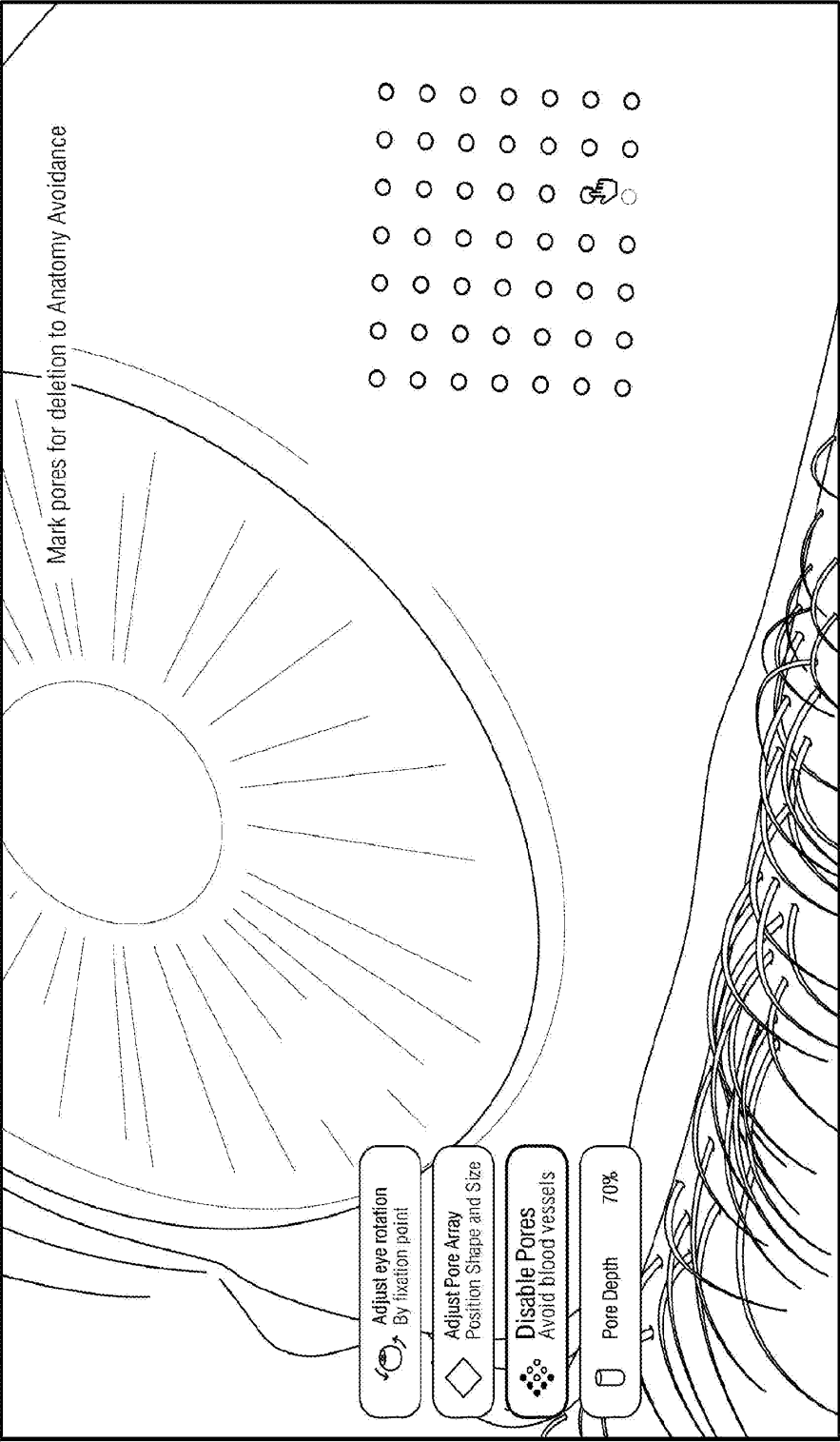


Fig. 64

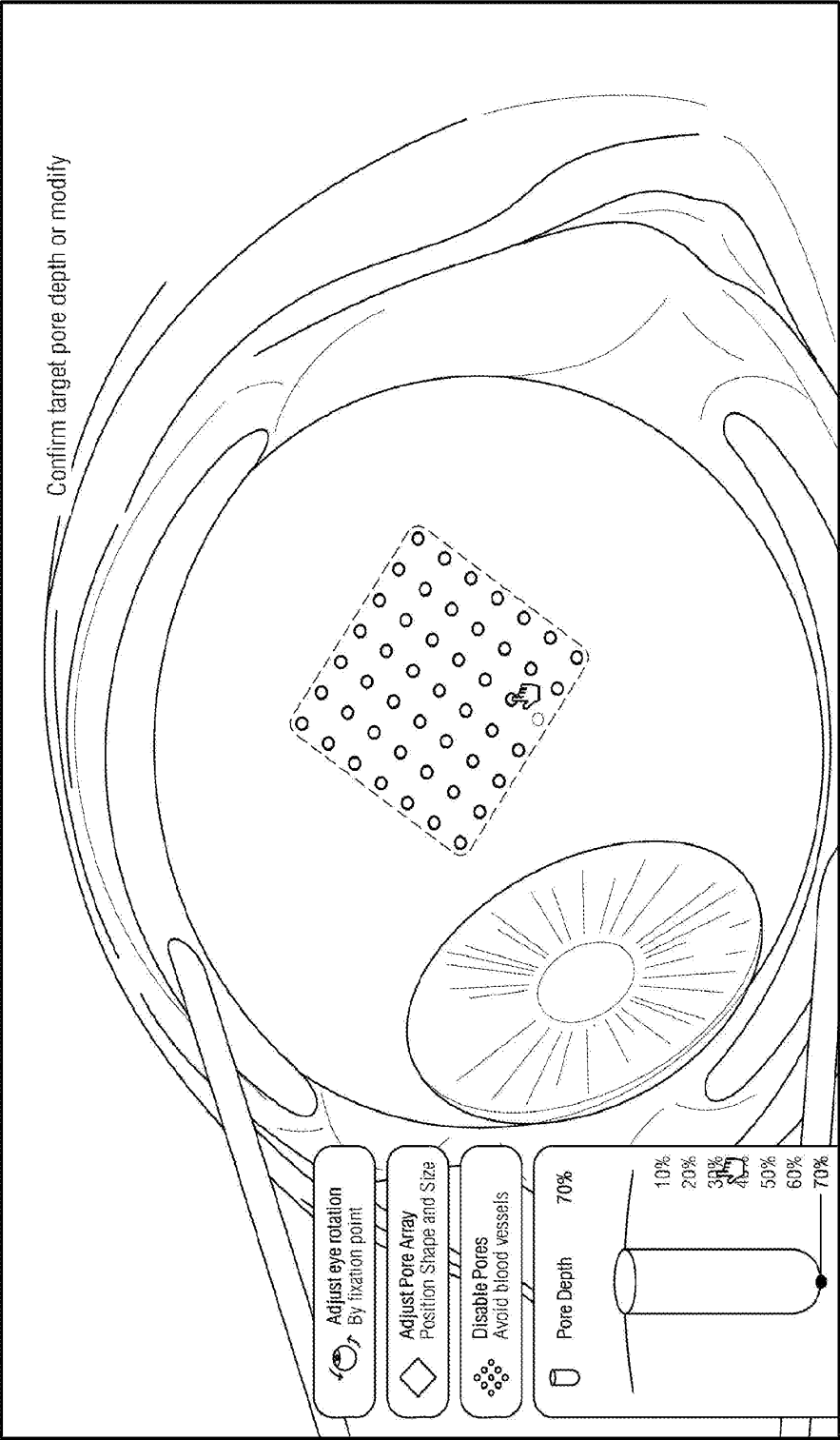


Fig. 65

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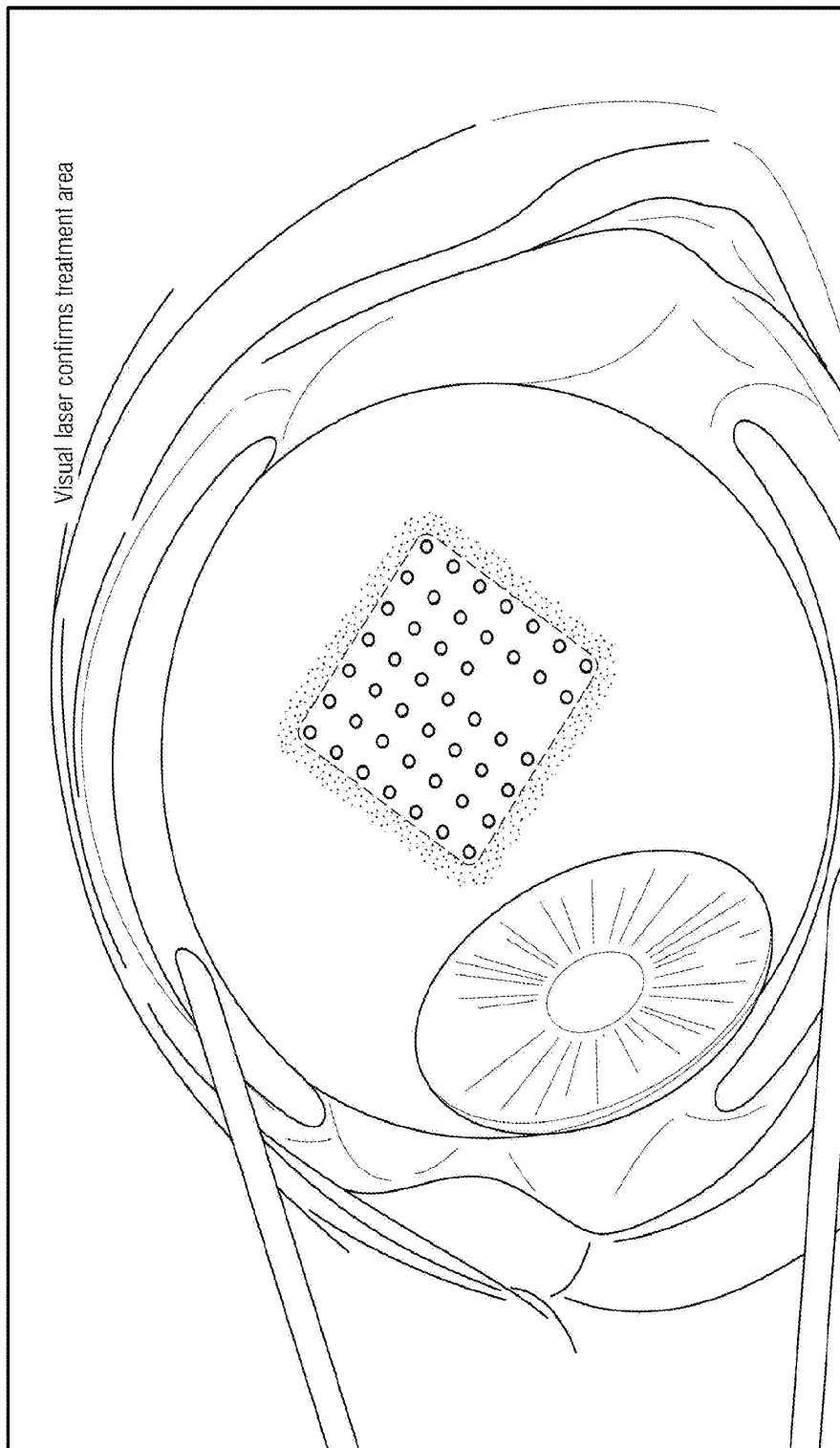


Fig. 66

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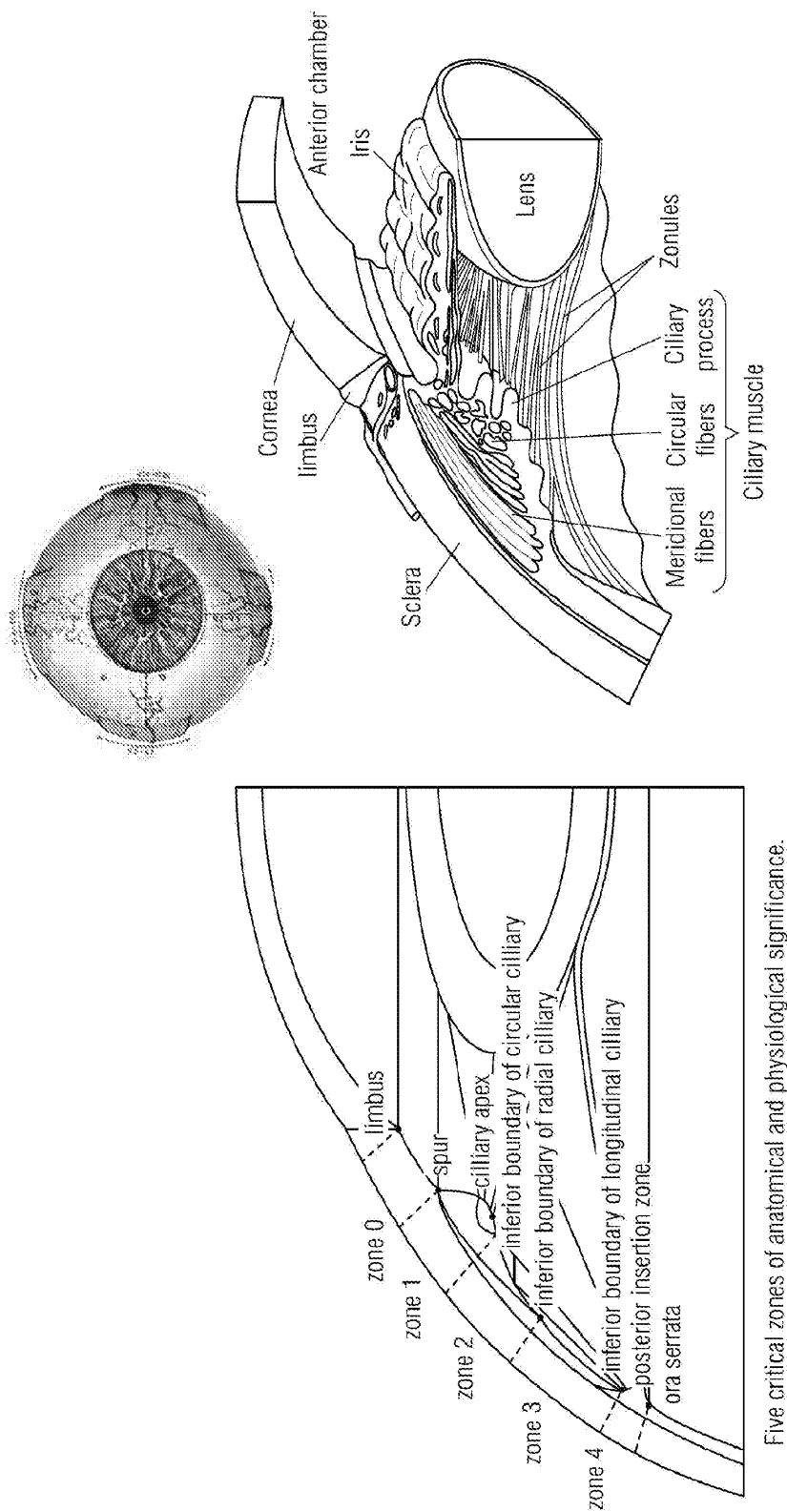


Fig. 67: Anterior Segment 5 Critical Zones

Five critical zones of anatomical and physiological significance.

- Zone 0) 0.0-1.3mm from anatomical limbus (AL); distance from the AL to the superior boundary of Schlemm's canal/scleral spur/ciliary muscle;
- Zone 1) 1.3-2.8mm from AL; distance from the sclera spur to the inferior boundary of the circular muscle;
- Zone 2) 2.8-4.7mm from AL; distance from the inferior boundary of the circular muscle to the inferior boundary of the radial muscle;
- Zone 3) 4.7-6.6mm from AL; inferior boundary of the radial muscle to the superior boundary of the posterior vitreous zonule zone; and
- Zone 4) 6.6-7.3mm from AL; superior boundary of the posterior vitreous zonule zone to the superior boundary of the ora serrata.

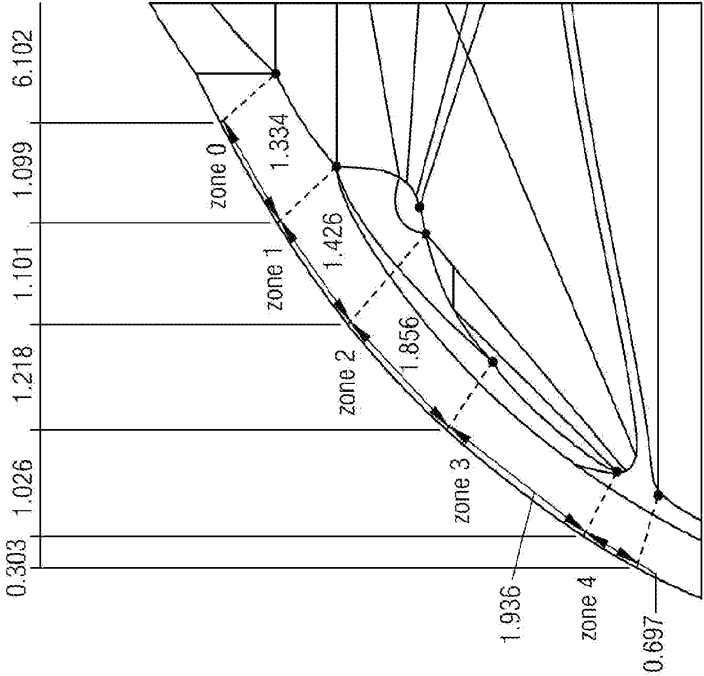


Fig. 68: 5 Critical Anterior Zones

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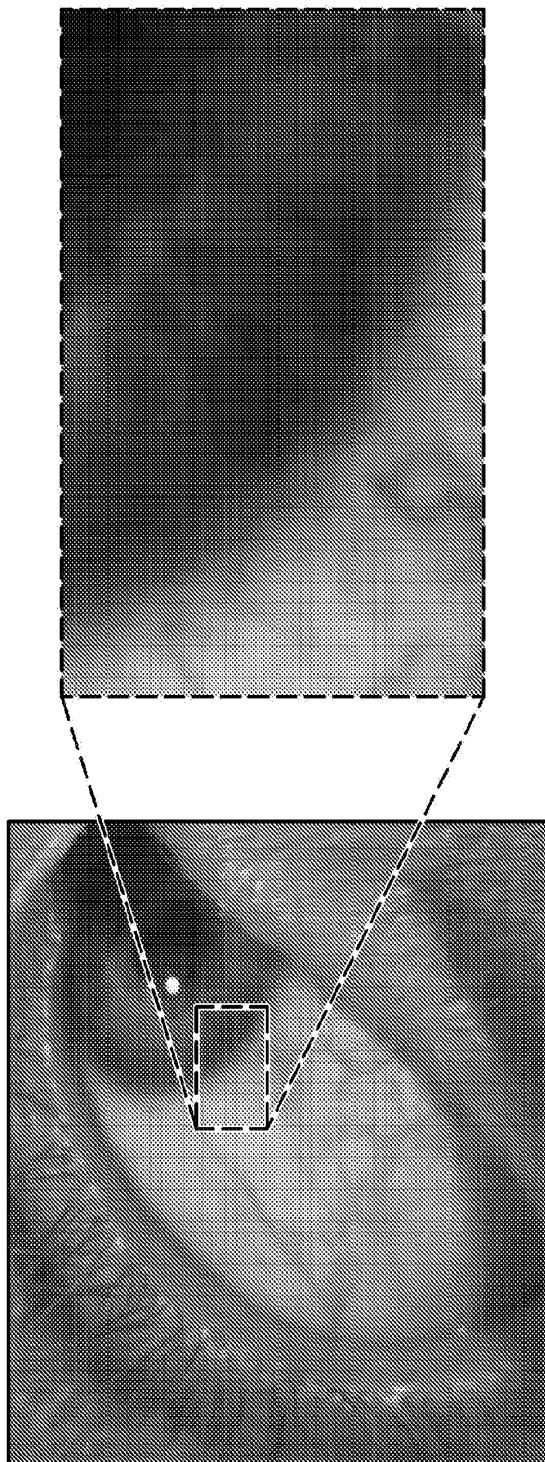


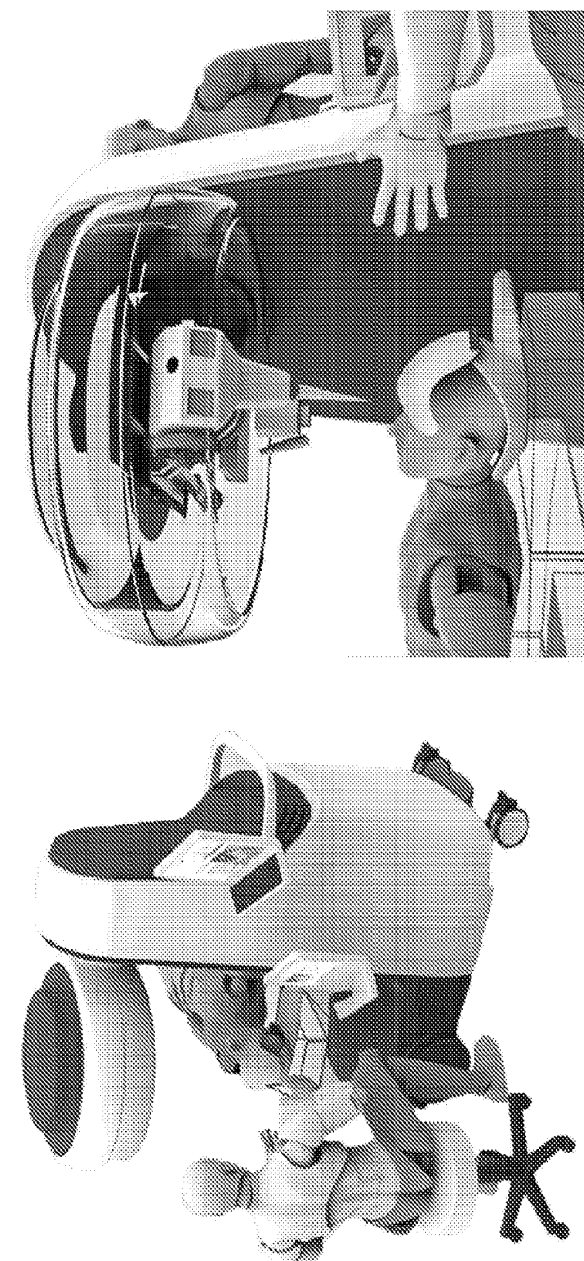
Fig. 69: Camera image on GUI shows High Resolution - Zoom Feature to show anatomical limbus as reference for Treatment Positioning

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Fig. 70: TIME OF FLIGHT (TOF) camera images for positioning of
the patient for treatment under the Laser Head

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- Semi-Automated
- Non-Contact
- Treatment < 10 min
- Real Time Depth Control
- Real Time OCT Imaging
- Innovative Eye Tracking
- Superior Safety

Fig. 71

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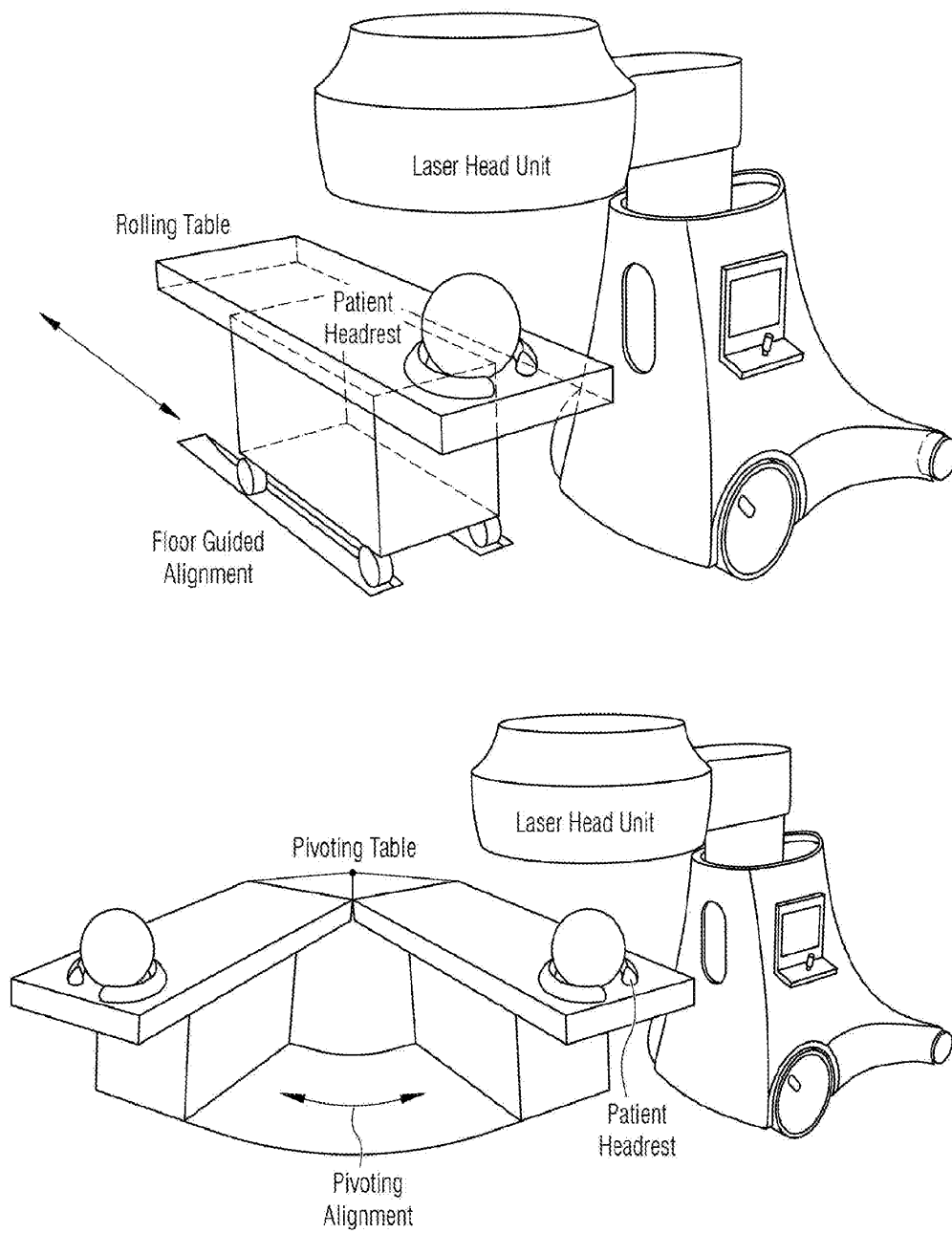


Fig. 72: System with Patient Chair –
rolling table or pivoting table or chair

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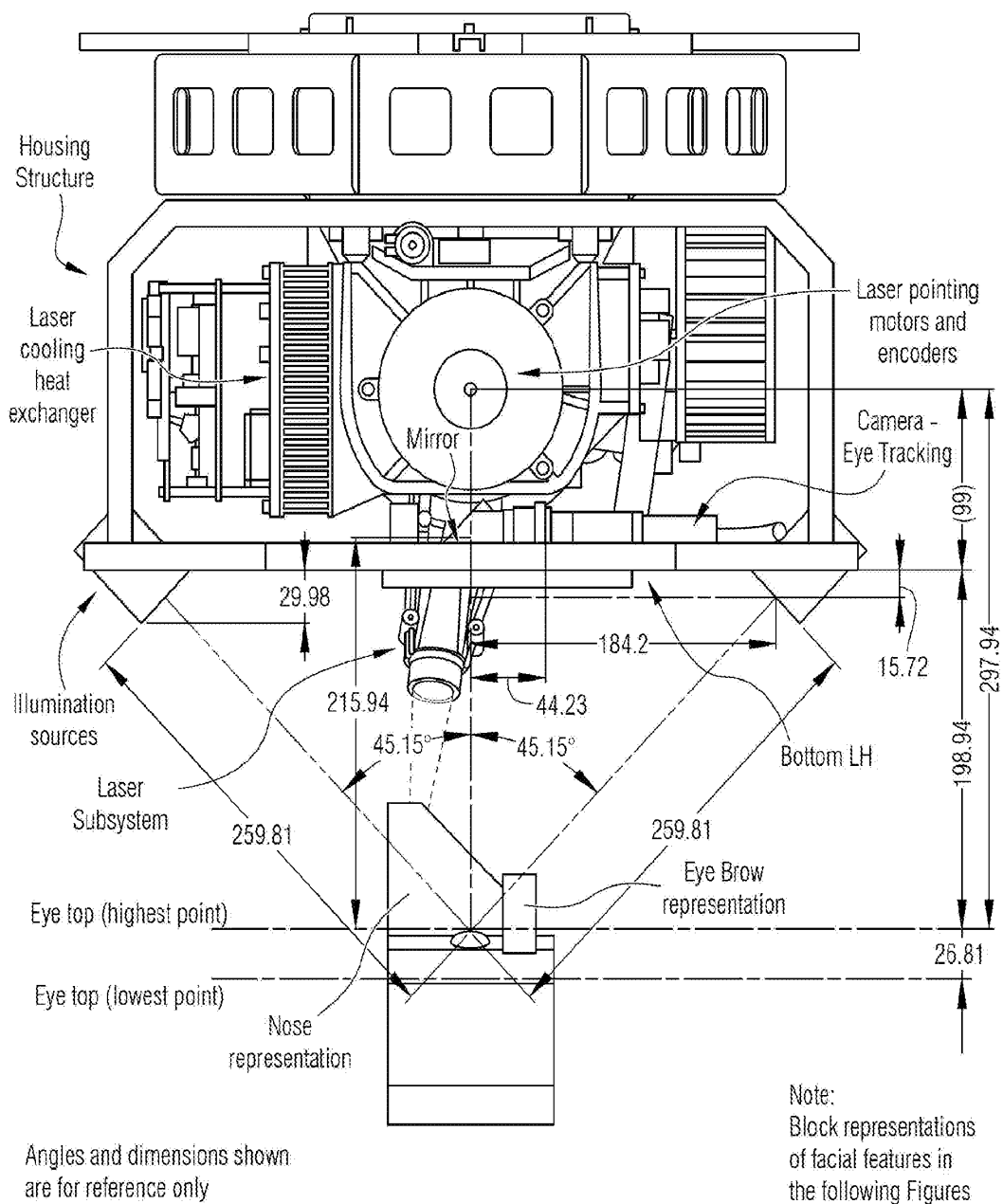


Fig. 73: Laser Head positions for each quadrant around facial features

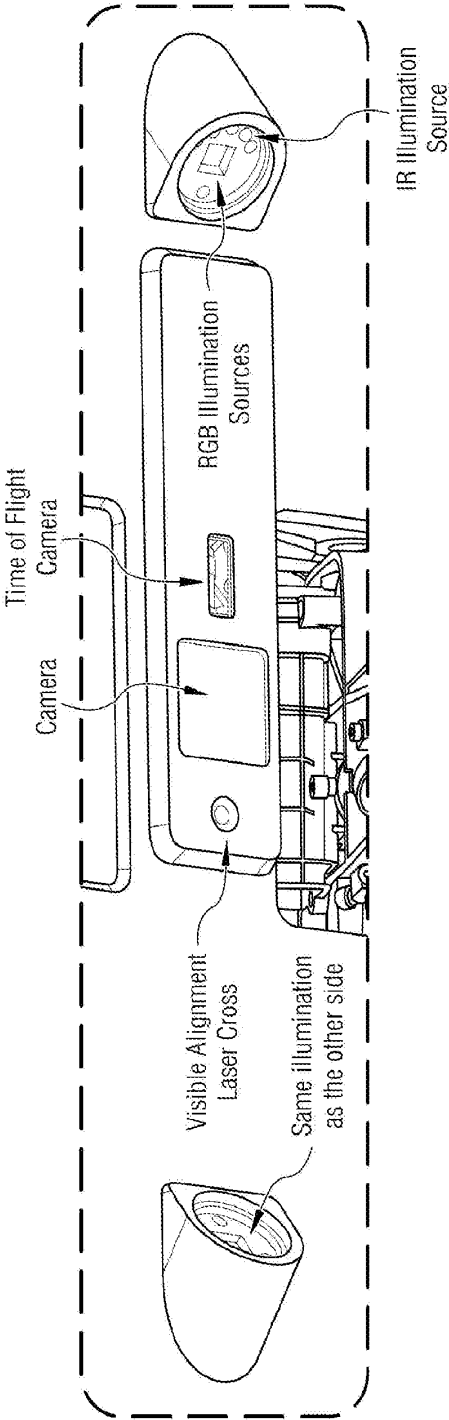


Fig. 74: Underside of the Laser Head System showing: Camera(s), Illumination Sources, Laser Cross and TOF Camera

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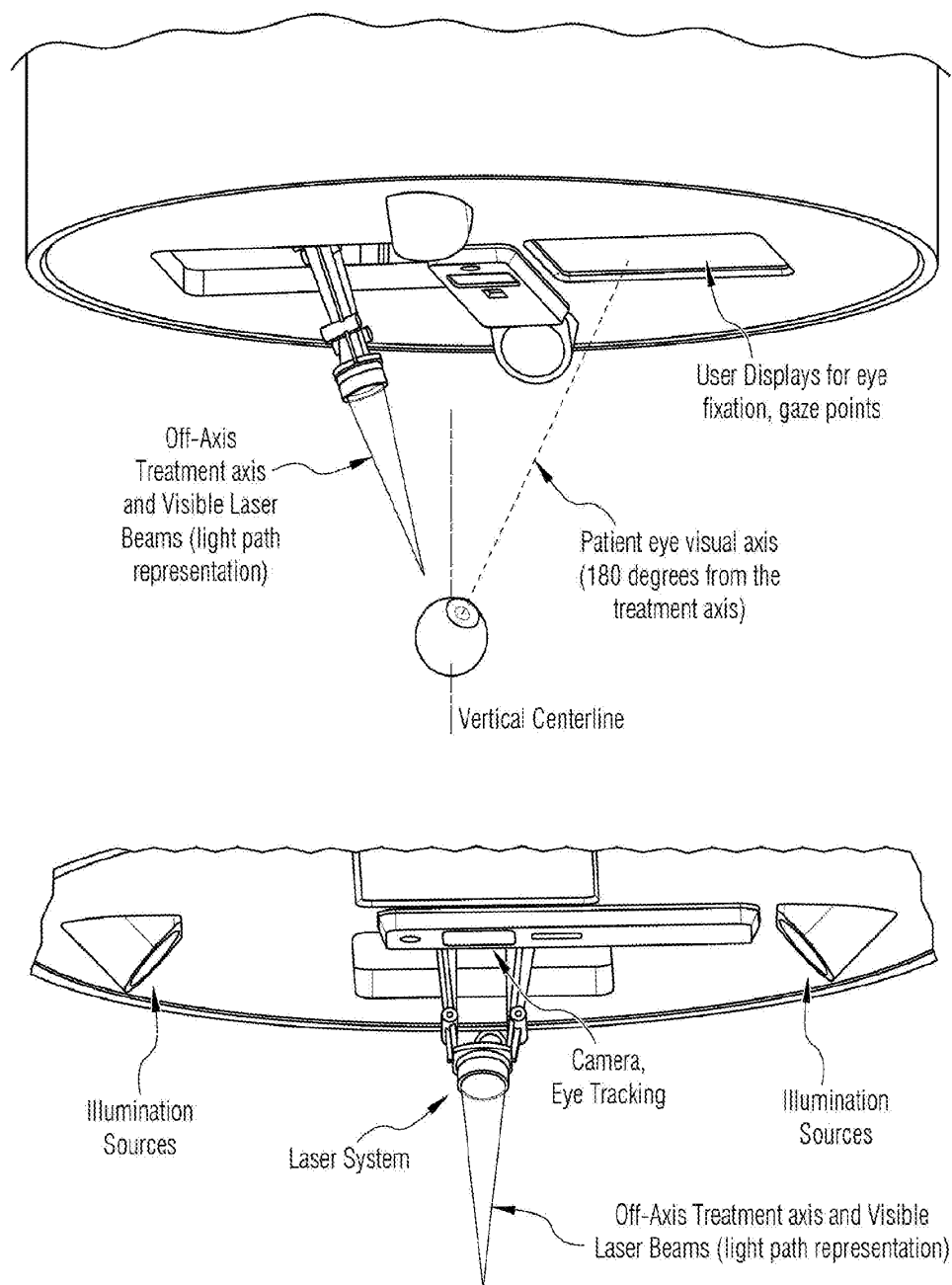


Image is looking up at the underside of the Laser Head System, without covers to show some functional components.

Fig. 75: Bottom view of the Laser Head complete

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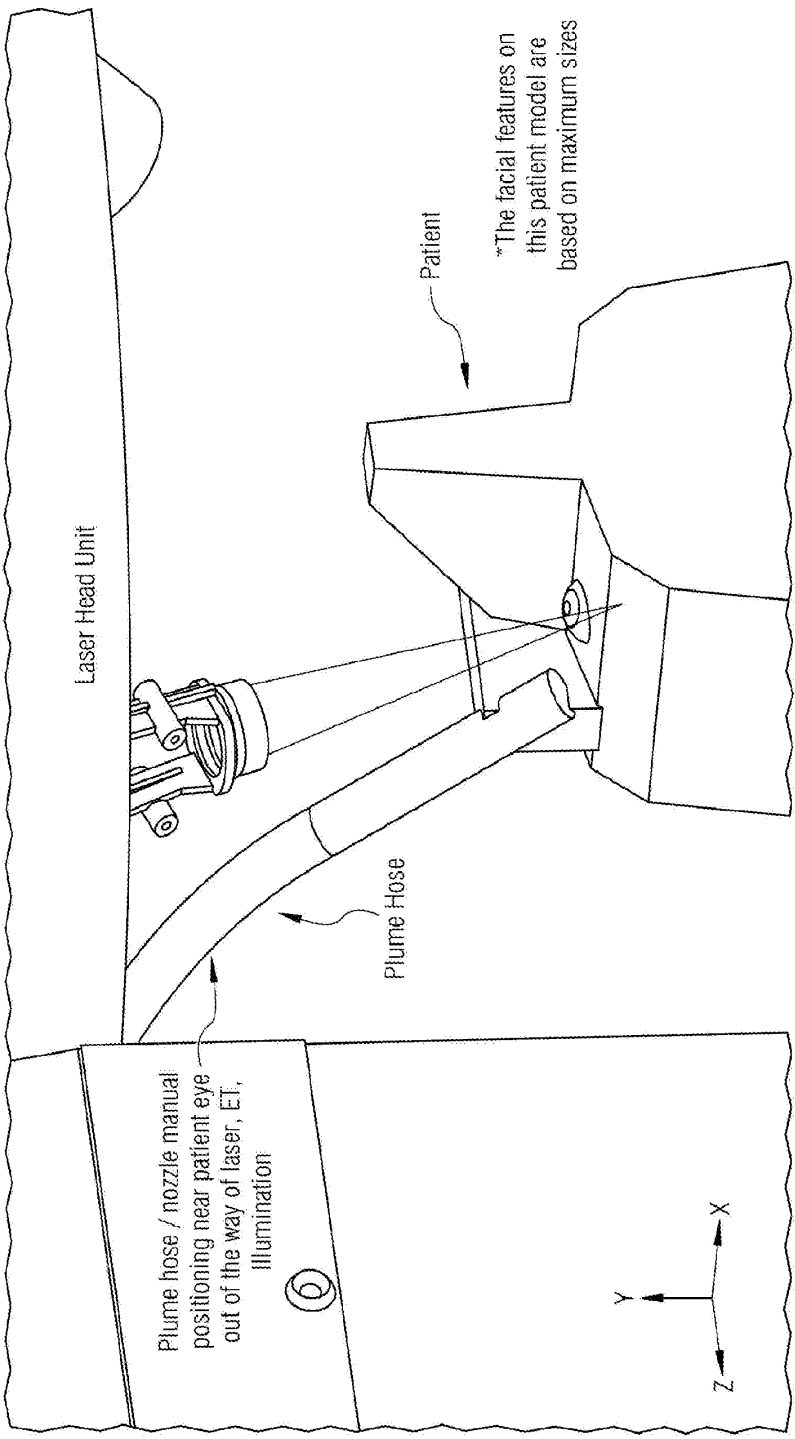


Fig. 76: System with Ablation Plume Removal

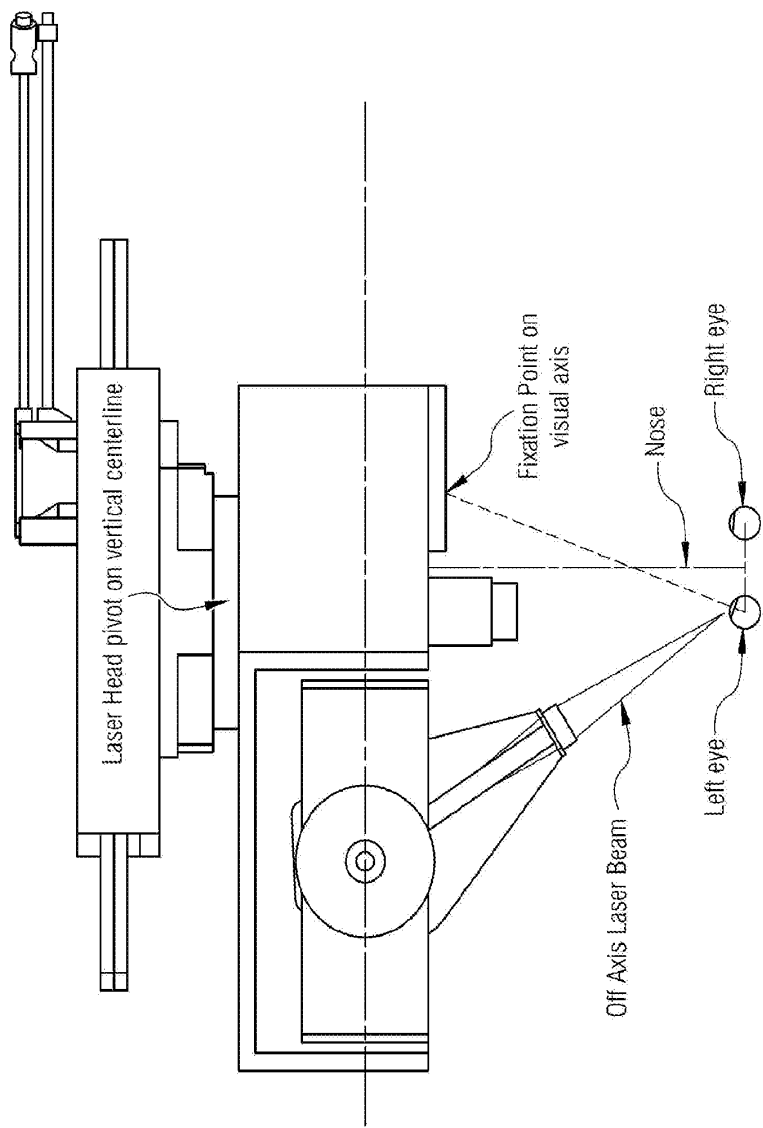


Fig. 77: Treatment laser and Eye Fixation System

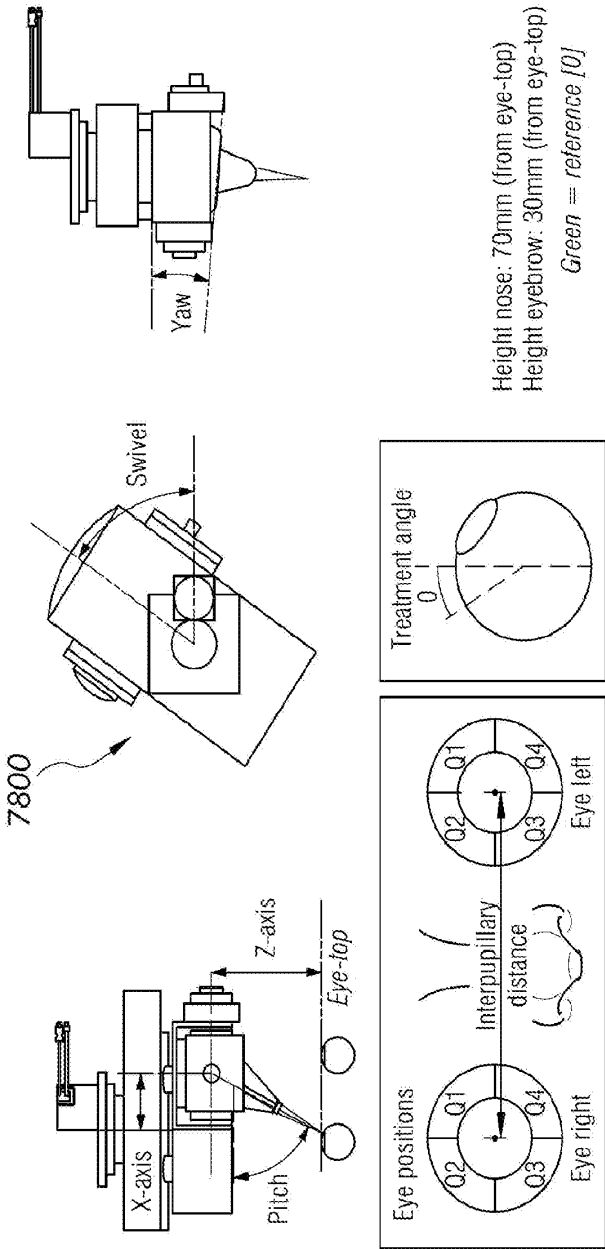


Fig. 78: Laser Head System Motions in No Galvo system

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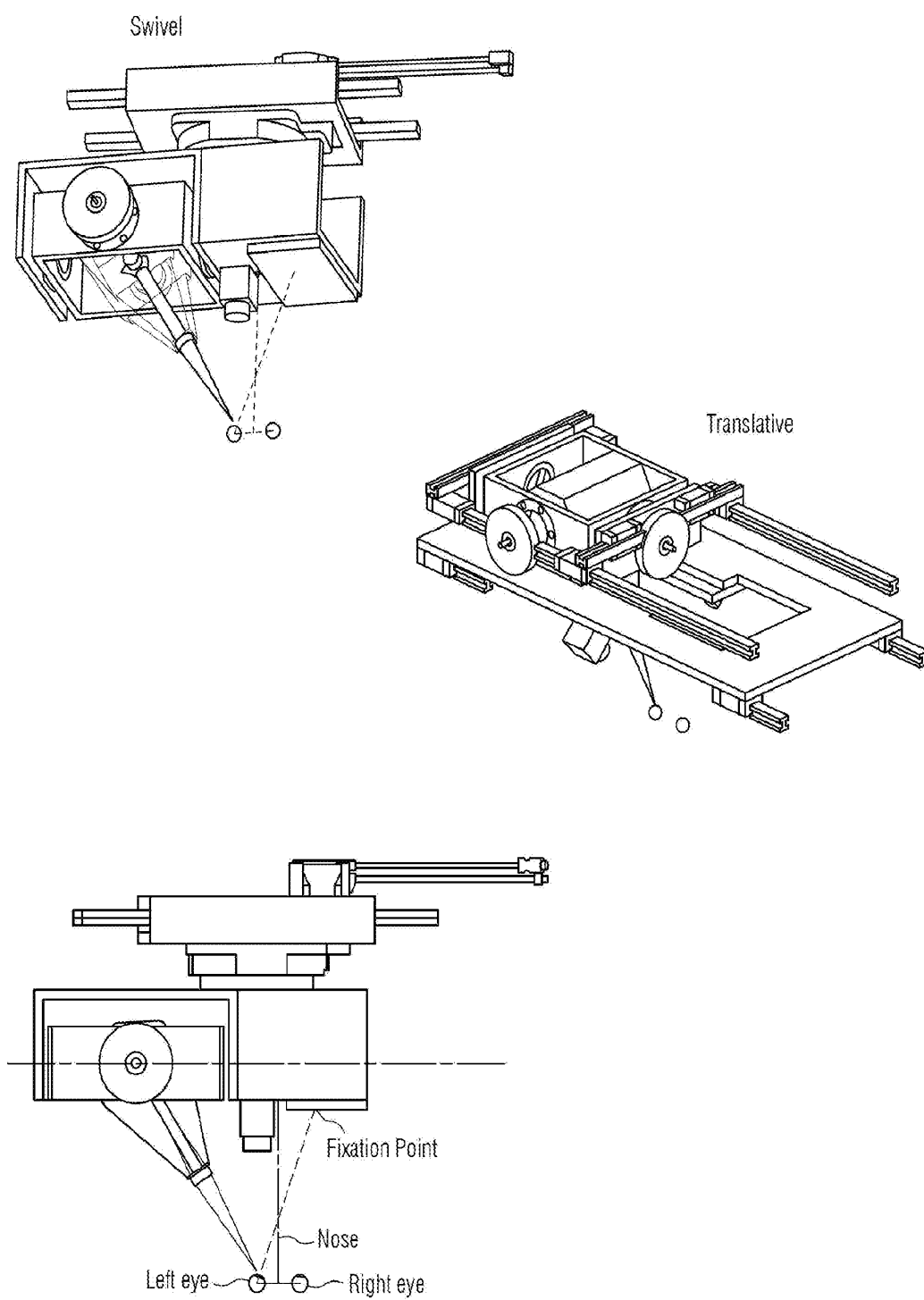


Fig. 79: Swivel and Translation motions

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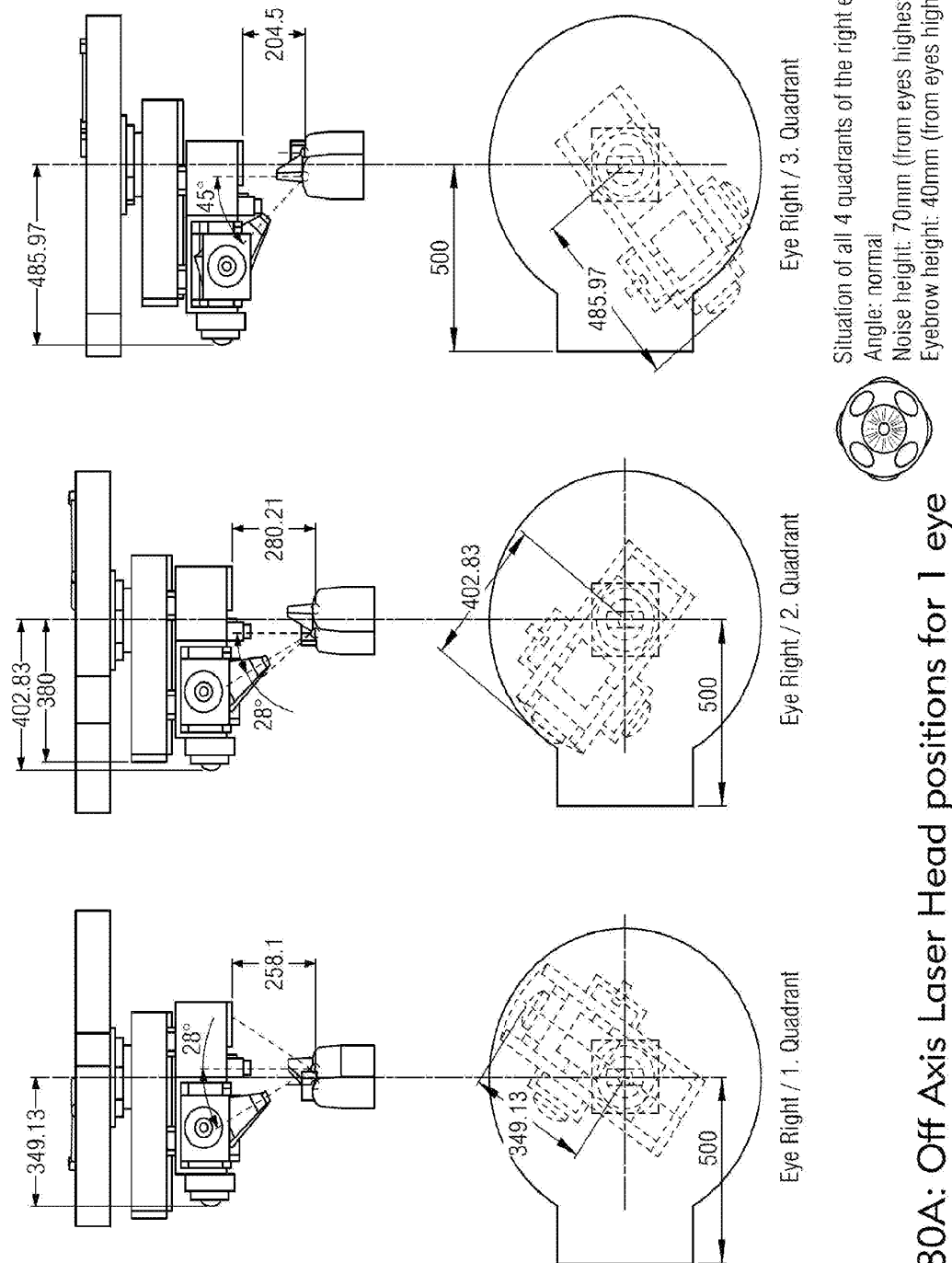


Fig. 80A: Off Axis Laser Head positions for 1 eye

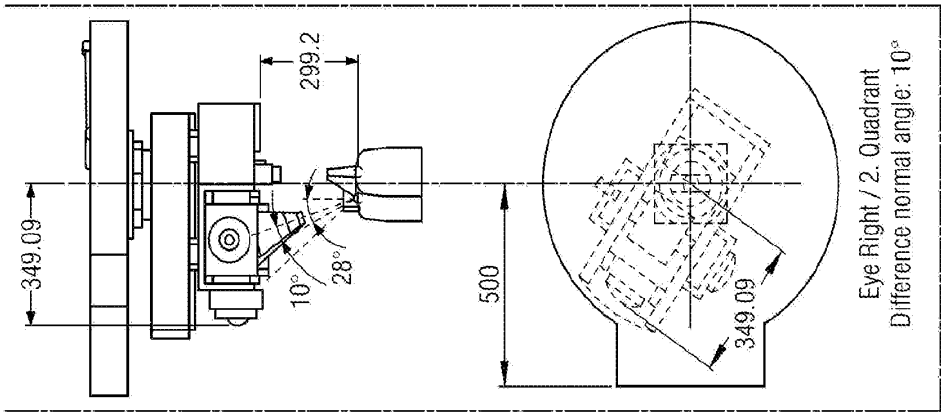
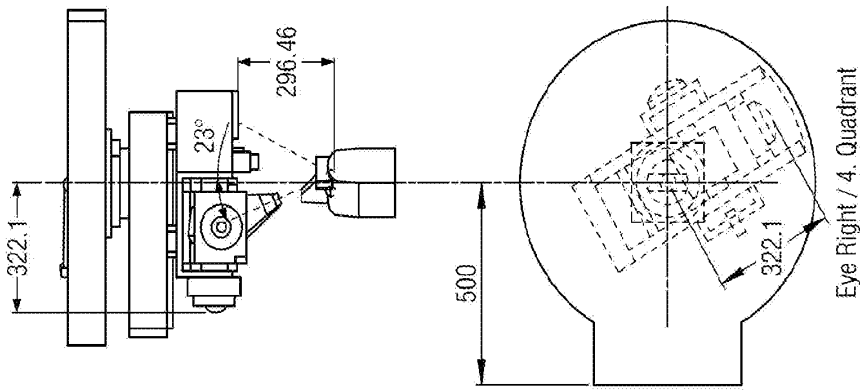
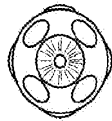


Fig. 80B: Off Axis Laser Head positions for 1 eye



Situation of all 4 quadrants of the right eye
Angle: normal
Noise height: 70mm (from eyes highest point)
Eyebrow height: 40mm (from eyes highest point)



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Eye position	Treatment Angle [°]	Pitch [°]	Yaw [°]	x-Axis [mm]	Swivel [°]	Z-Axis [mm]
Eye right Q1 77mm	28	62.58	-5.89	136.99	56.18	297.94
Eye right Q2 77mm	28	62.3	-4.27	190.69	143.06	297.95
Eye right Q3 77mm	28	62.3	-4.27	190.69	216.94	297.95
Eye right Q4 77mm	23	67.71	-5.83	109.99	301.09	310.83
Eye left Q1 77mm	28	62.58	-5.89	136.99	123.82	297.94
Eye left Q2 77mm	28	62.3	-4.27	190.69	36.94	297.95
Eye left Q3 77mm	28	62.3	-4.27	190.69	323.06	297.95
Eye left Q4 77mm	23	67.71	-5.83	109.99	238.91	310.83
Eye right Q1 55mm	25	65.3	-3.98	127.1	53.58	305.98
Eye right Q2 55mm	28	62.17	-3.19	182.02	141.02	297.96
Eye right Q3 55mm	28	62.17	-5.19	182.02	218.98	297.96
Eye right Q4 55mm	16	74.5	-4.00	76.49	300.86	324.75
Eye left Q1 55mm	25	65.3	-3.98	127.1	126.42	305.98
Eye left Q2 55mm	28	62.17	-3.19	182.02	38.98	297.96
Eye left Q3 55mm	28	62.17	-3.19	182.02	321.02	297.96
Eye left Q4 55mm	16	74.5	-4.01	76.49	239.14	324.75
Max. Difference:		62.17	+5.89	114.2	-	26.81
		74.5	-5.89	-	-	-

See Fig E1 for definition of Pitch, Yaw and Swivel Angles and dimensions shown are for reference only

Fig. 81: Details Eye Position per quadrant and treatment angles shown in Figure E1

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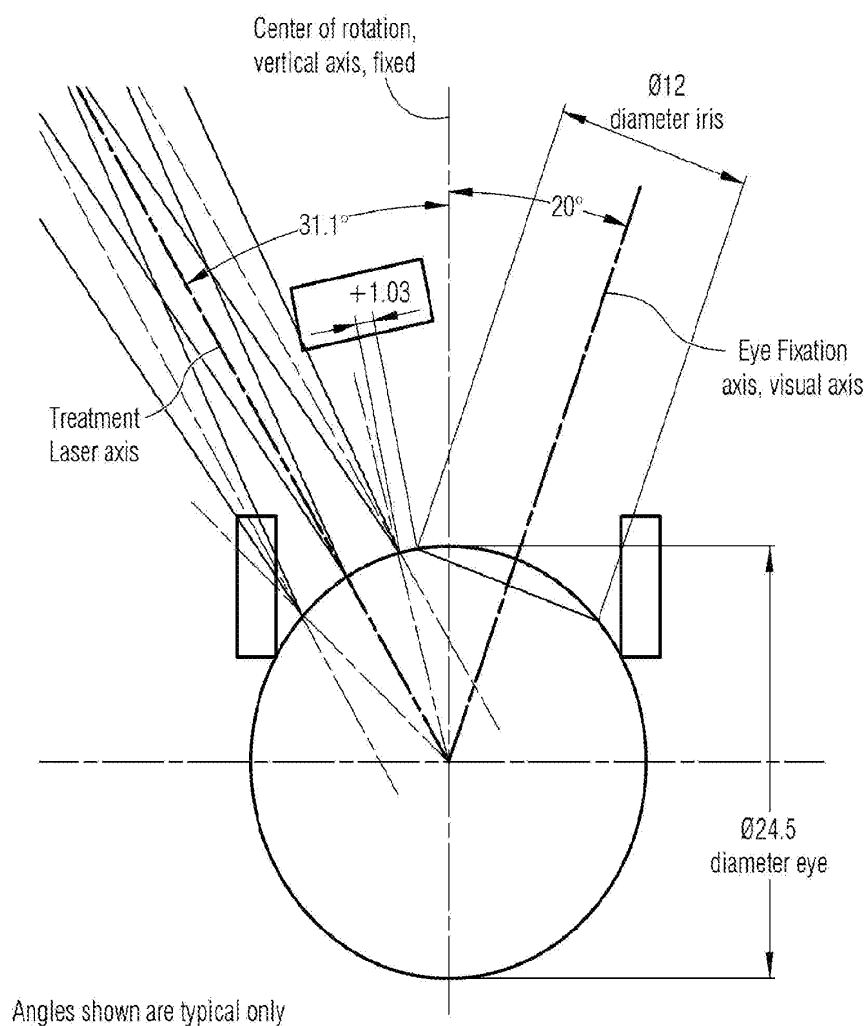


Fig. 82: Laser Focal and Angular Positions in relation to the top of the eye for off-axis treatment

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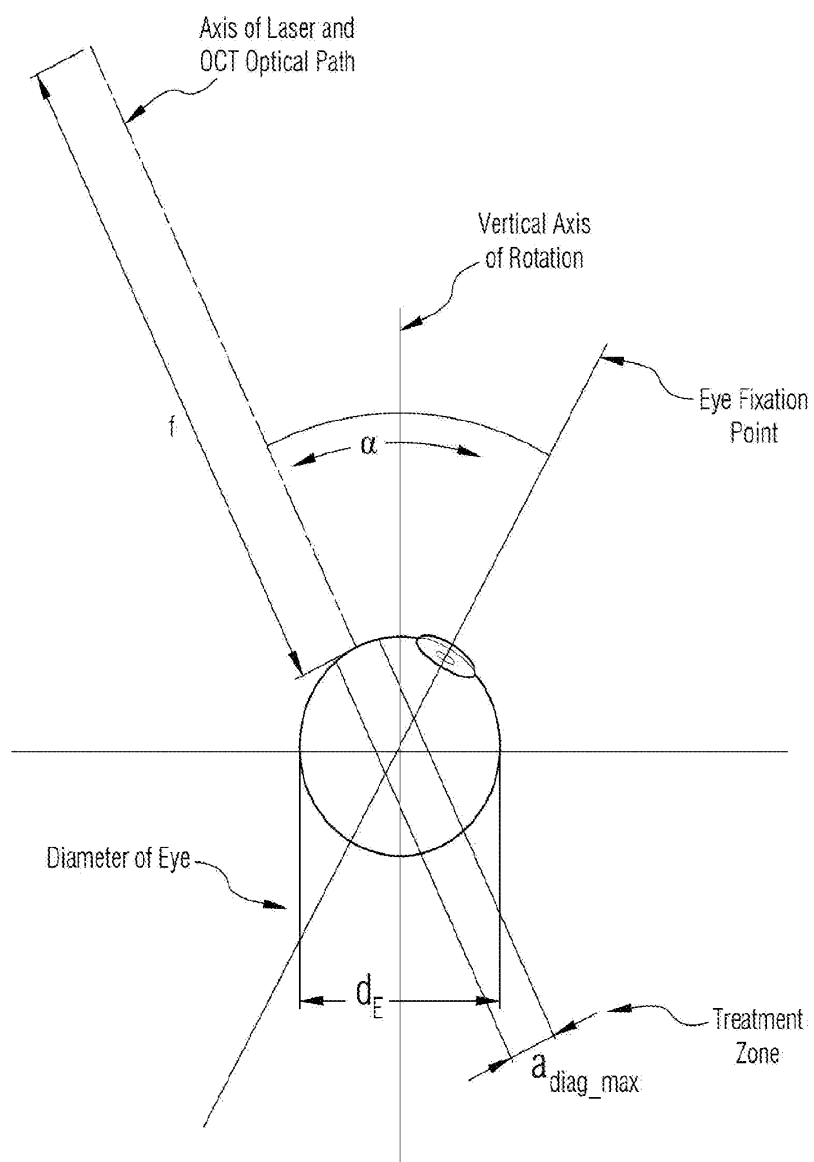


Fig. 83

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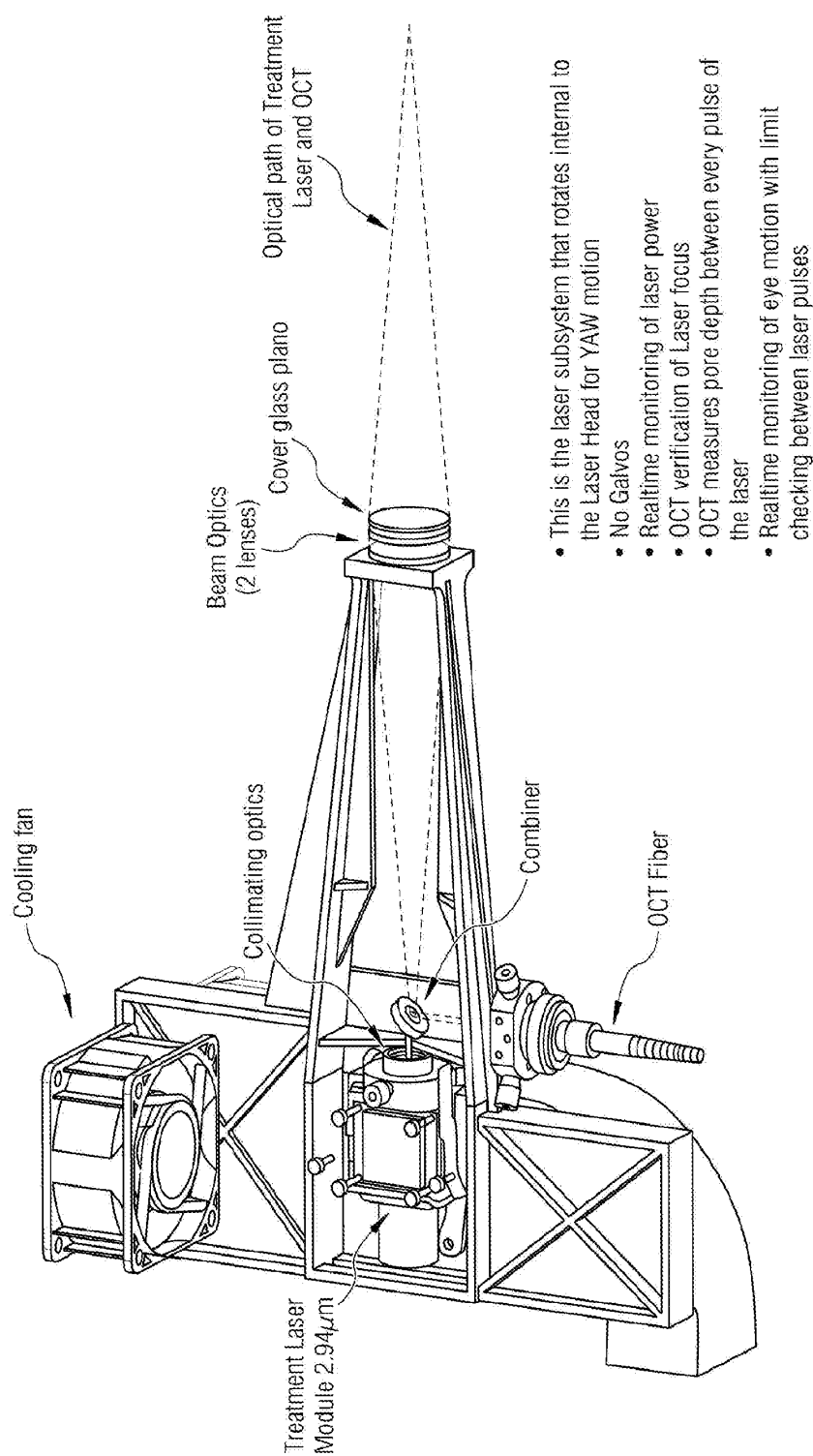


Fig. 84: Laser subsystem to combined treatment laser with fiber based OCT/DC

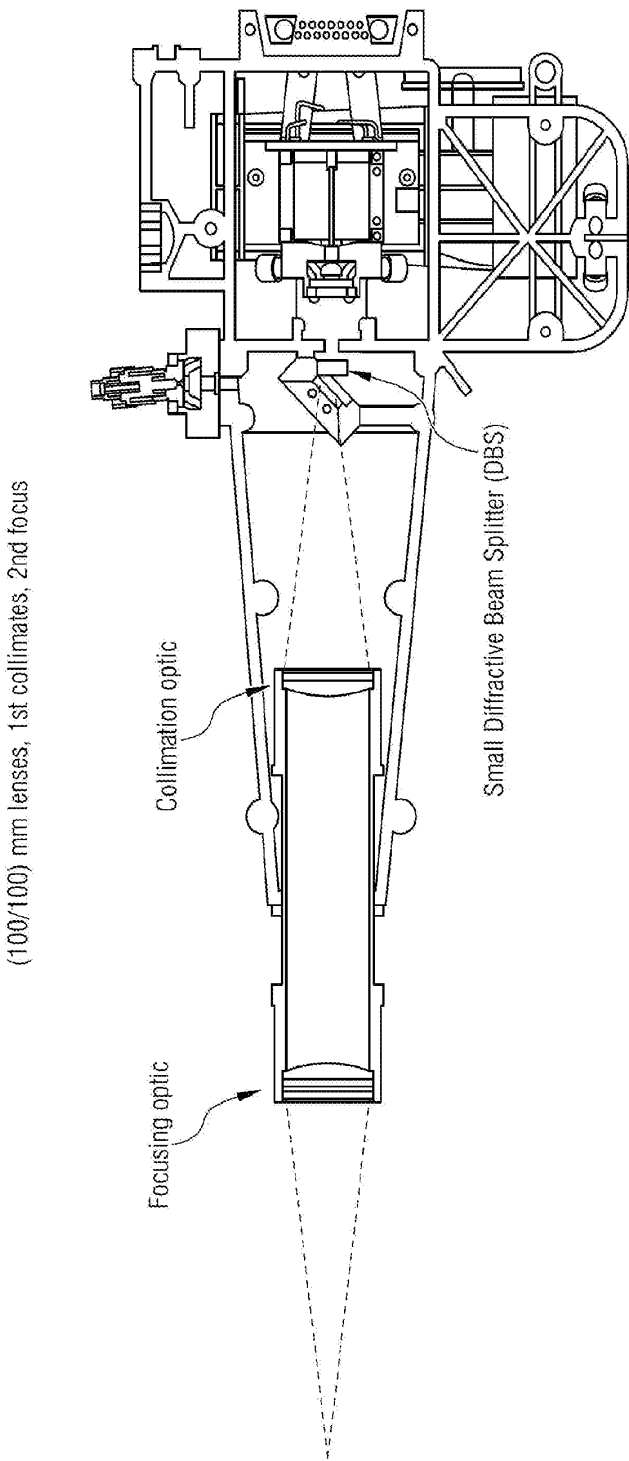


Fig. 85: Laser Subsystem with fixed focus and a small DBS

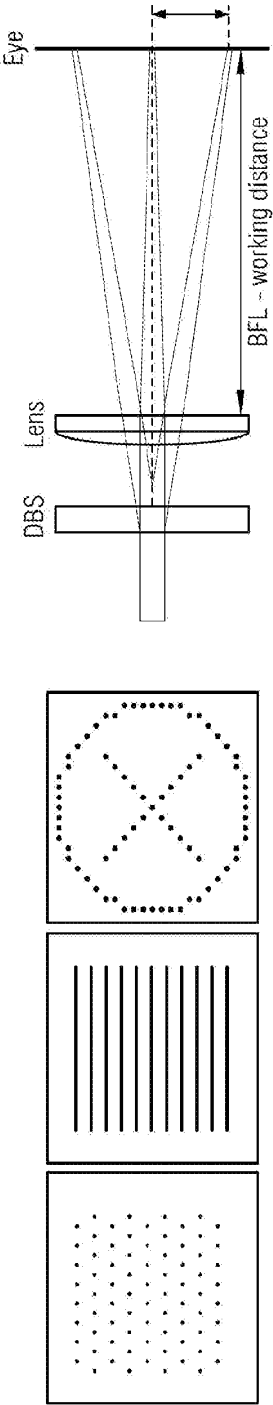


Fig. 86: Using DBS to alter size and shape of beam

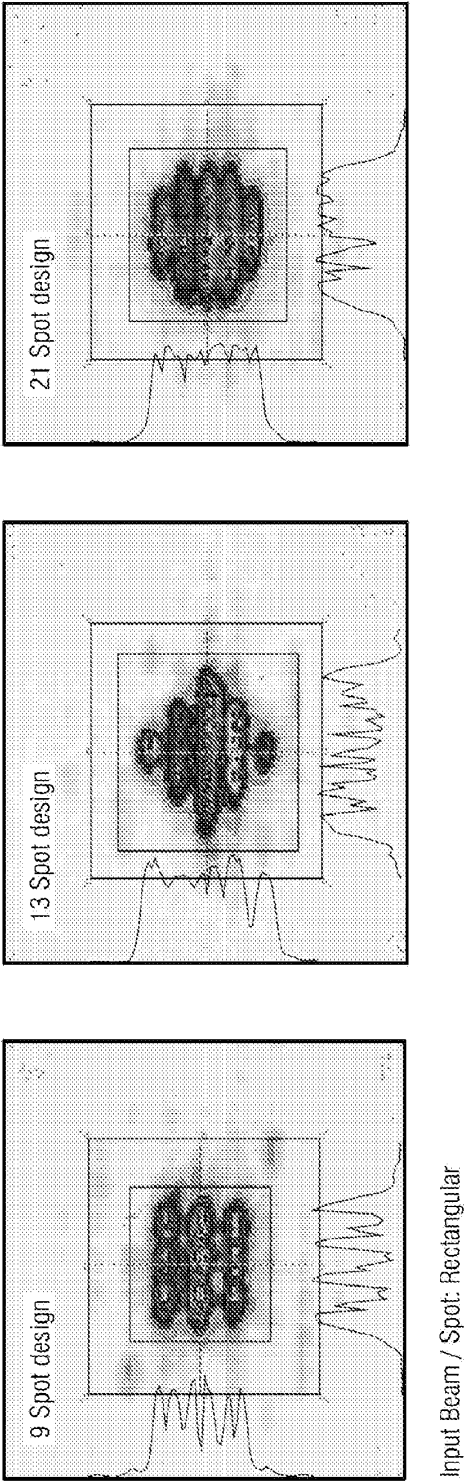


Fig. 87: Beam profiles for DBS with 150/150 divergent beam

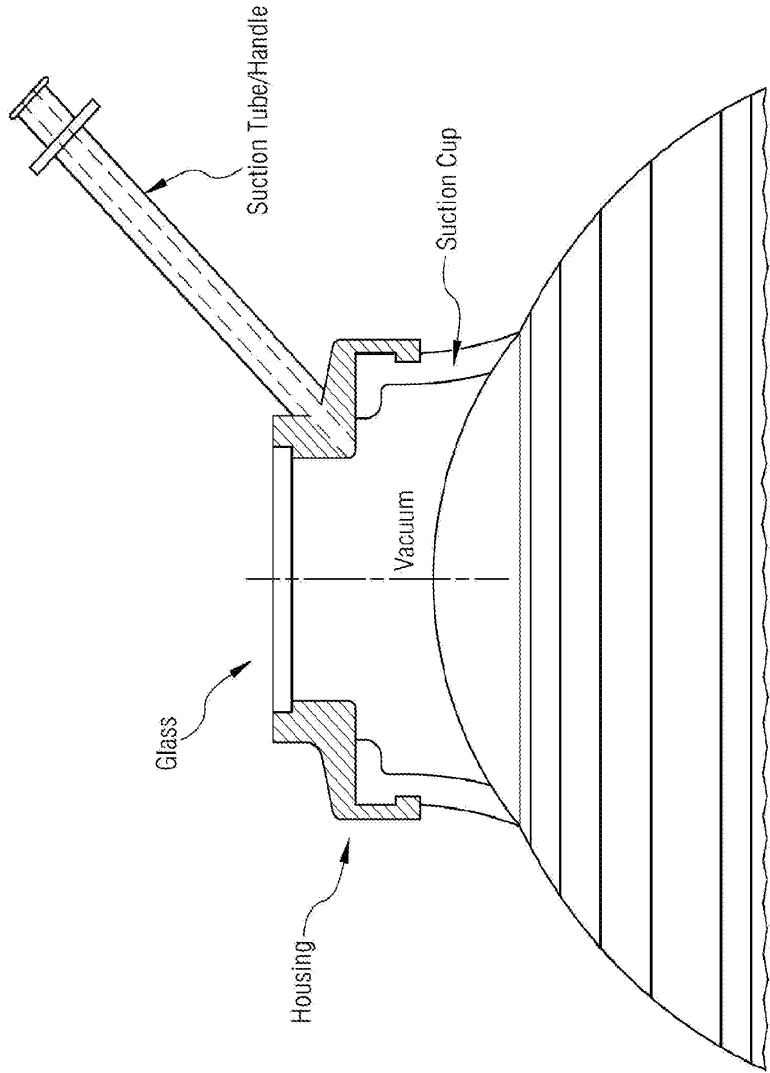
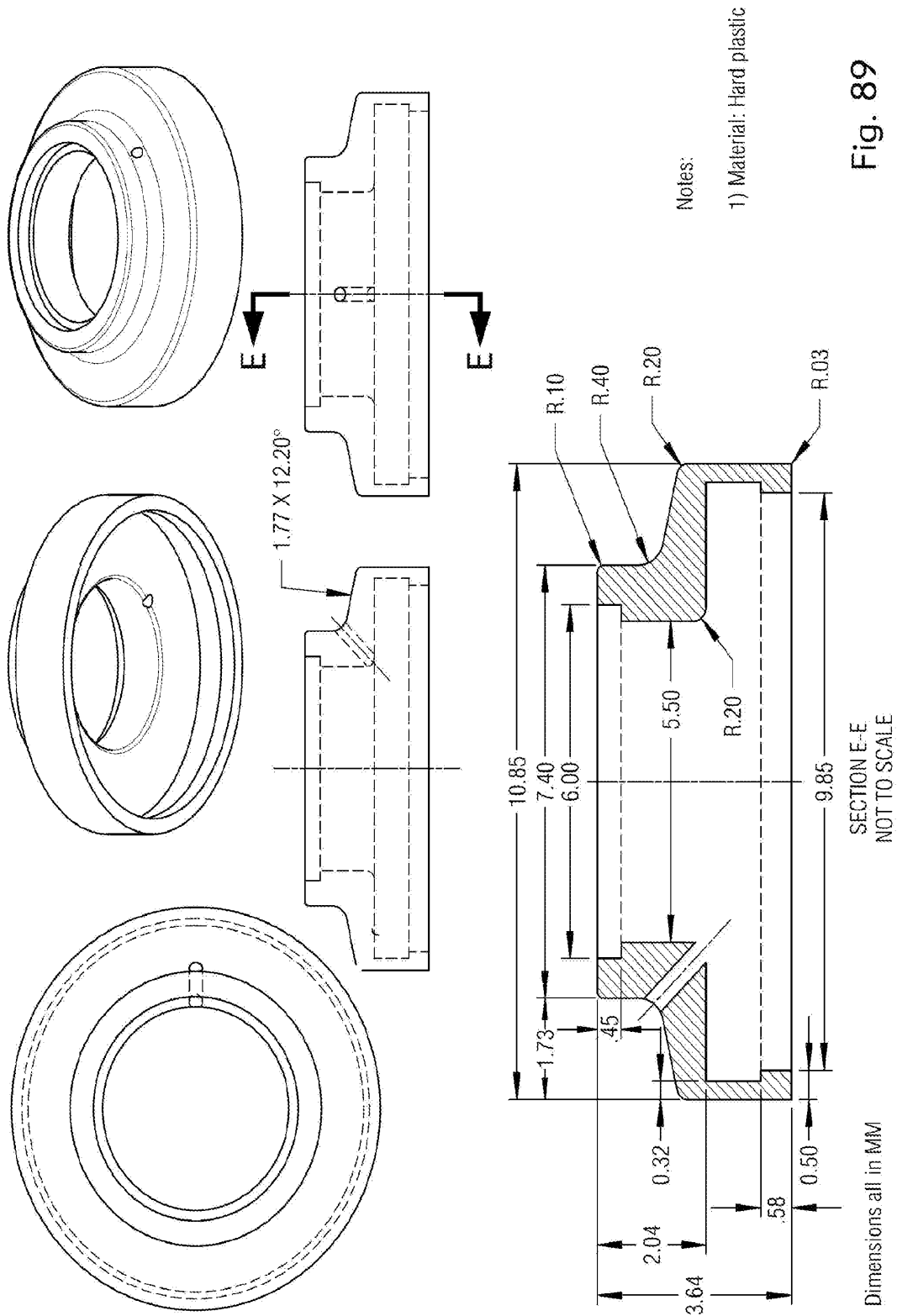
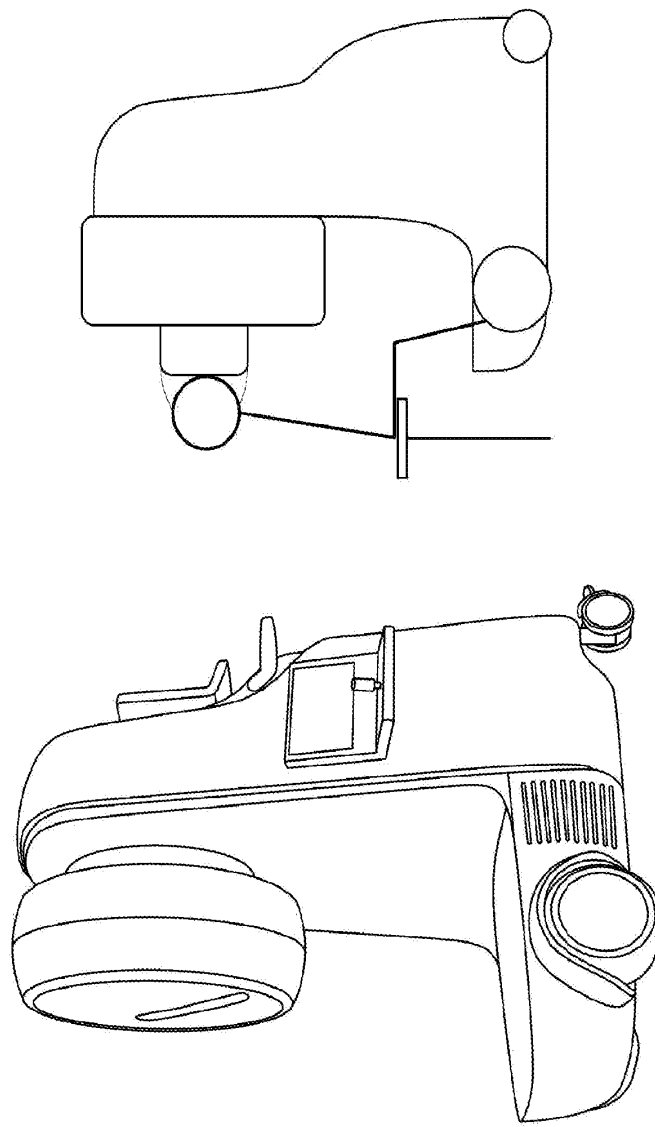


Fig. 88: Eye Docking Accessory

- Attached to handheld suction device
- Doctor attaches and hold position for treatment
- The glass could be protective from treatment wavelength emissions



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- Semi-Automated
- Non-Contact
- Treatment < 10 min
- Real Time Depth Control
- Real Time OCT Imaging
- Innovative Eye Tracking
- Superior Safety

Fig. 90: AVG Product Concept System with patient in the sitting position

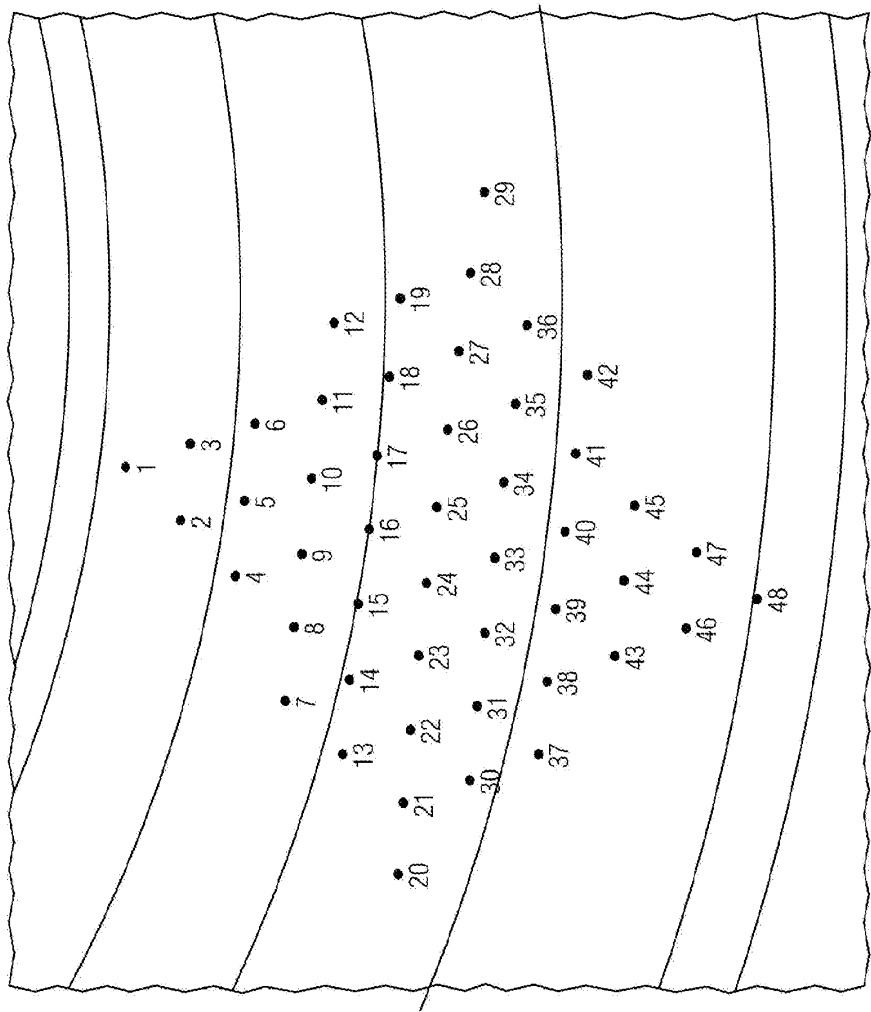


Fig. 91: View of treatment area and numbered micropore treatment order

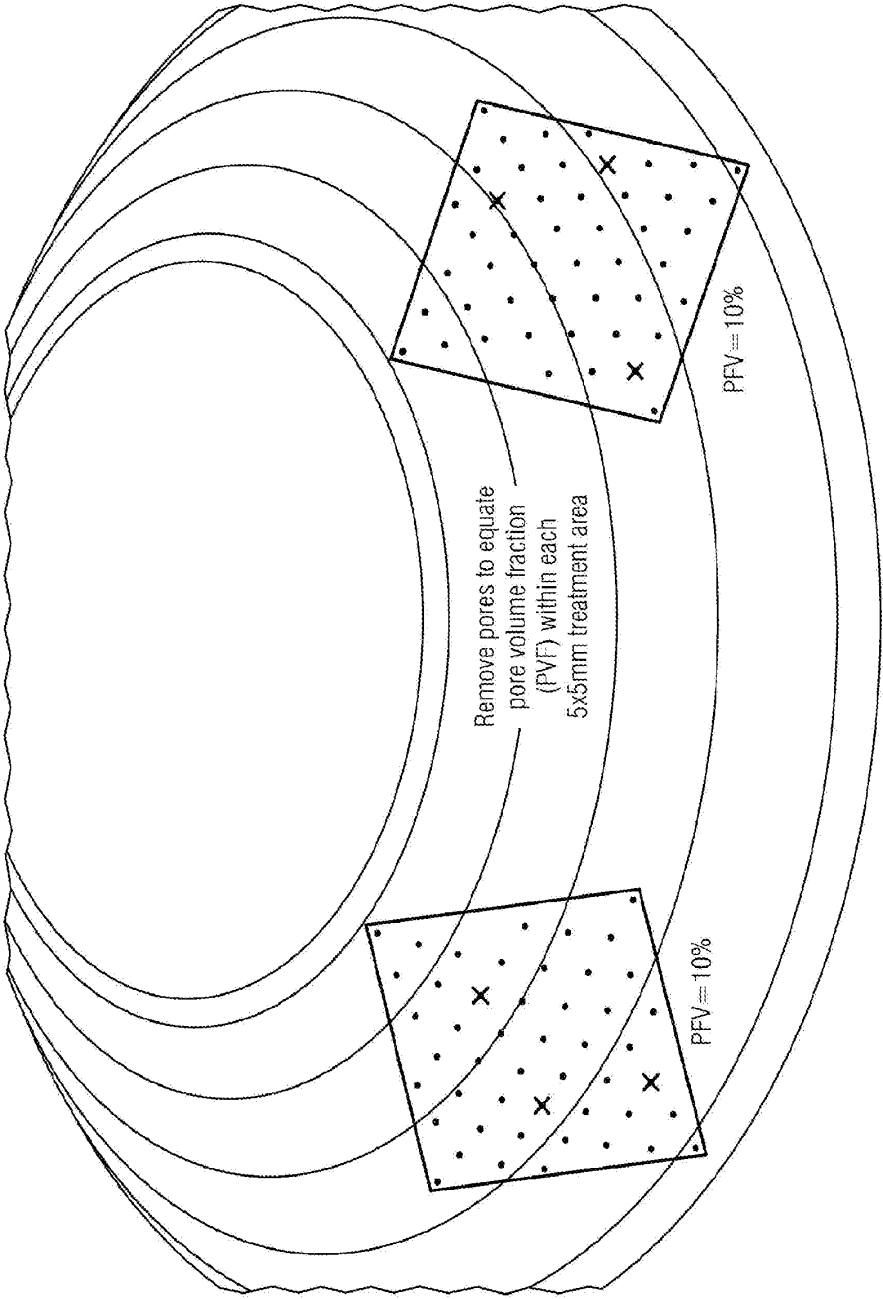


Fig. 92: View of treatment area and zones on eye globe

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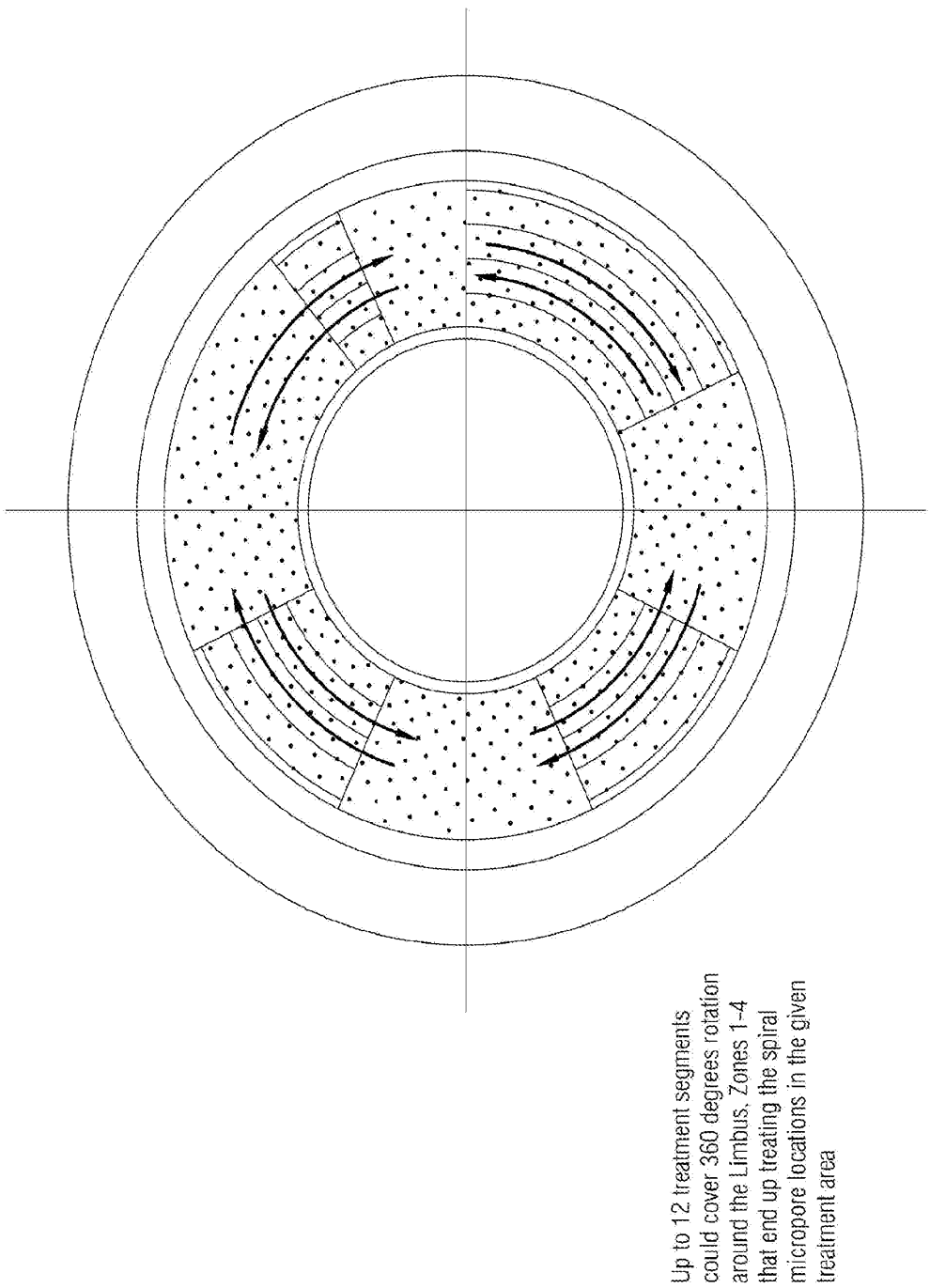
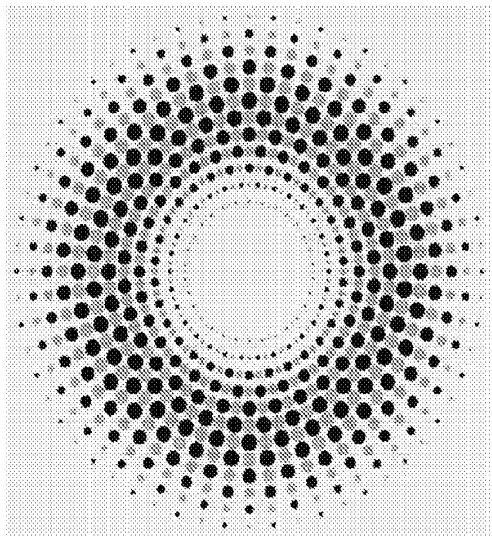
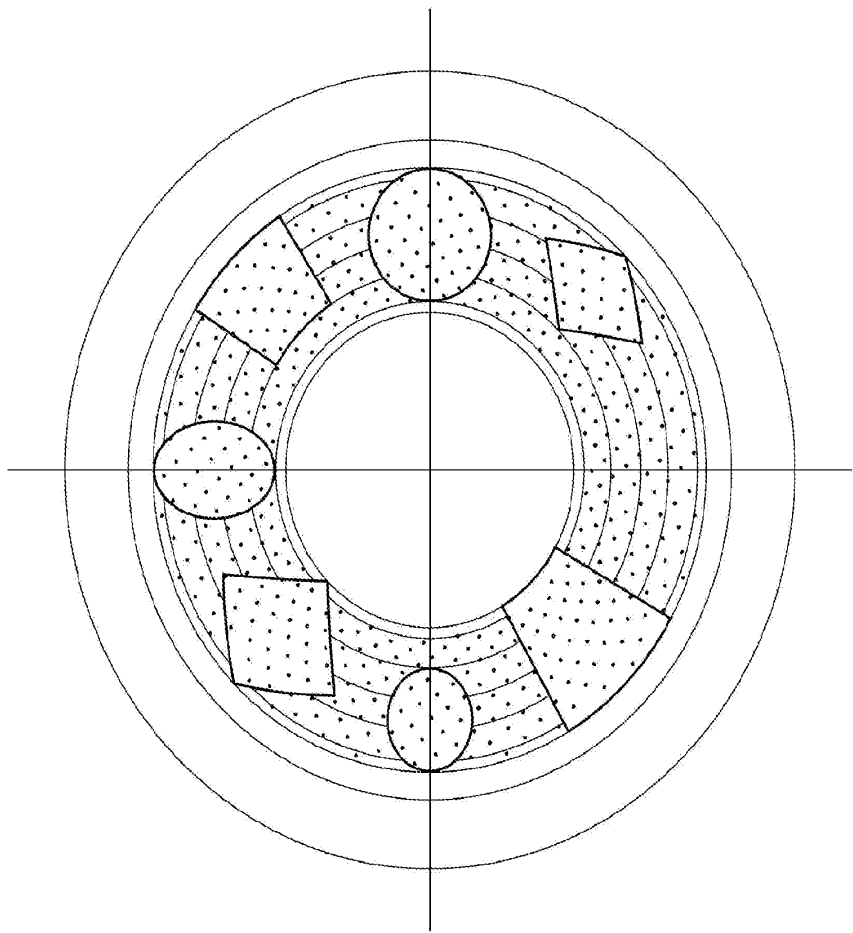


Fig. 93: New Modified Fig 2K-18 Treatment areas for 360degree treatments

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Patterns pre-defined to sum up to a spiral or other 360deg treatment pattern.
Predefined by order, # of pores and pore locations in the pattern

Fig. 94: Golden Spiral created from individual treatment patterns – pattern formation is one pass CW/ one pass CCW for the portion of the pattern in quadrant. Density related

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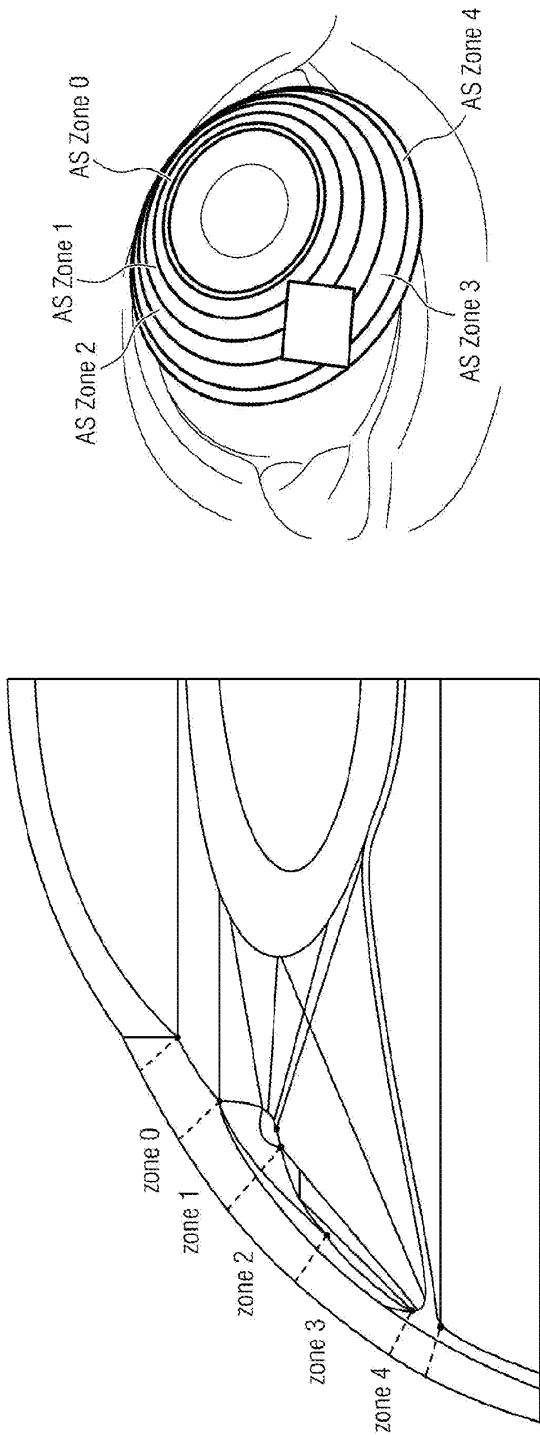


Fig. 95: Anterior Segment 5 Critical Zones

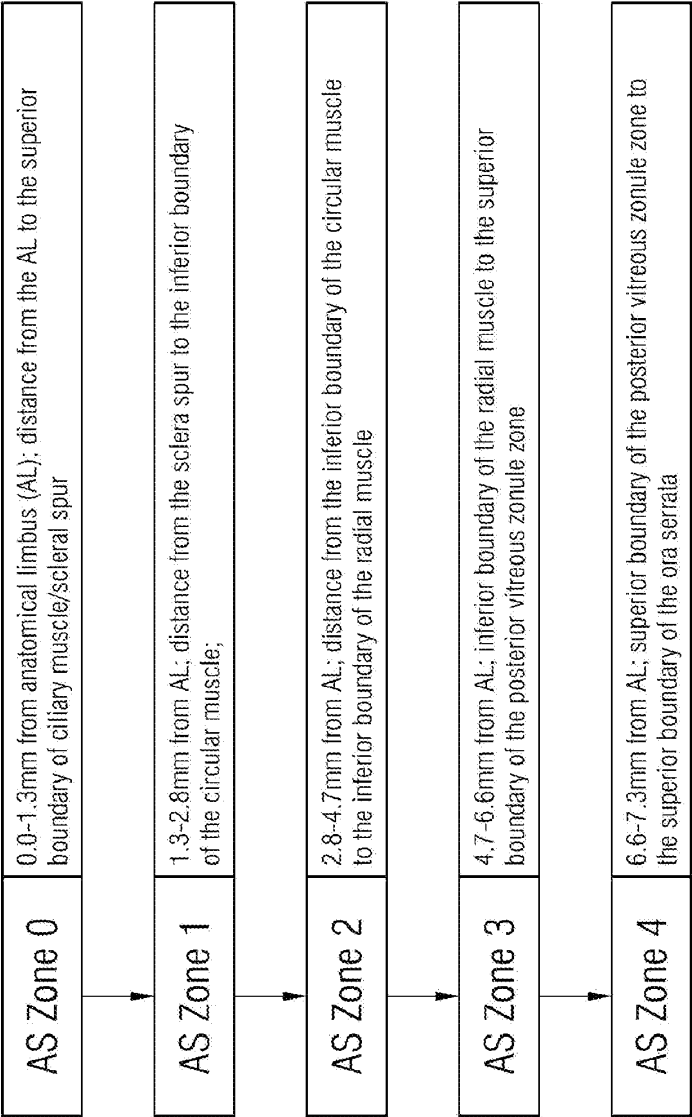


Fig. 96: Anterior Segment Zone Descriptions

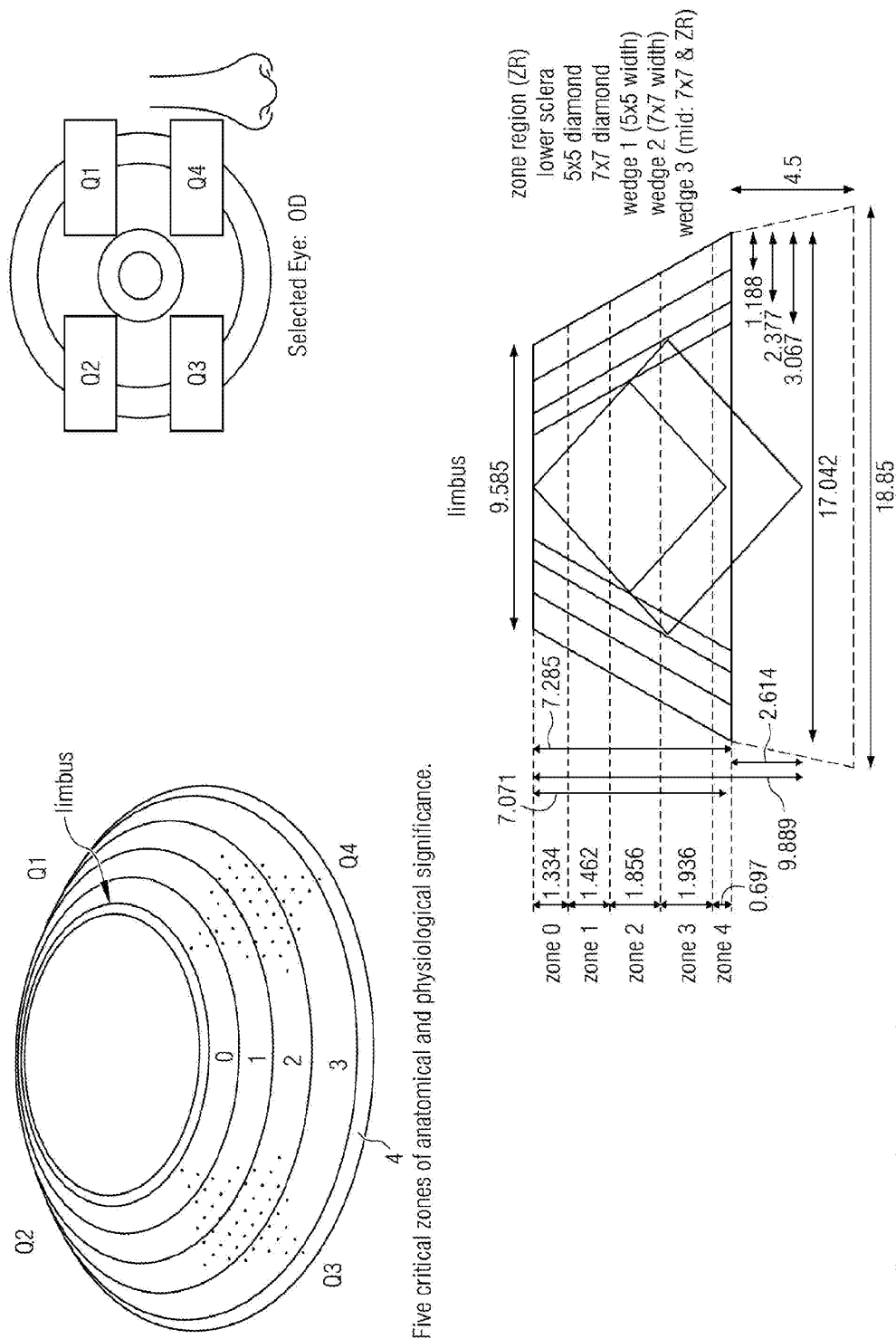


Figure 97: 5 Critical Anterior Zones

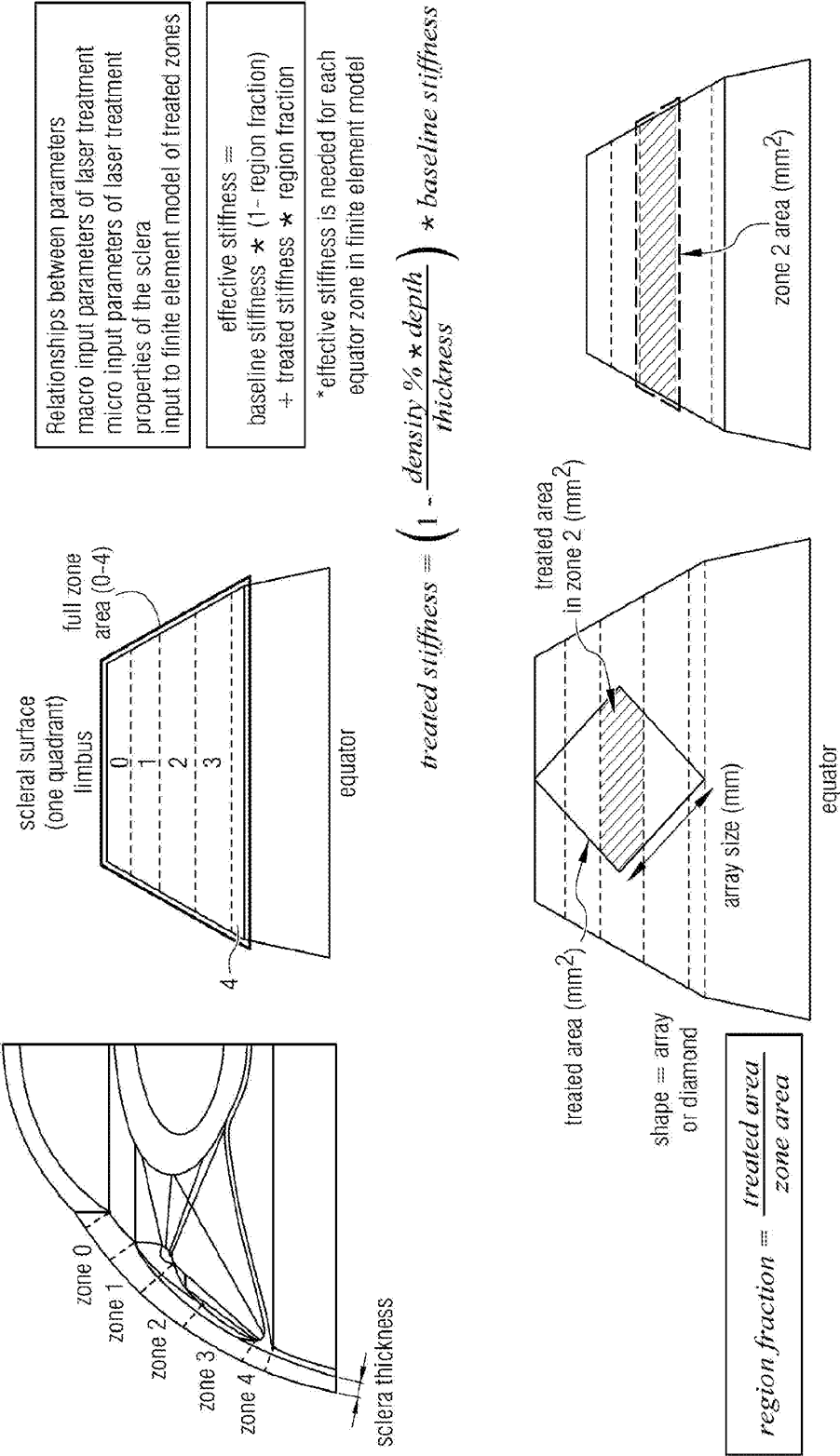


Fig. 98: Macro parameter definitions for Anterior Zones

- baseline simulation: original model of healthy accommodation with "old" sclera

 - stiff starting sclera: modulus of elasticity (E) = 2.85 MPa, equivalent to ~50 years old
 - tight attachment between the sclera and the ciliary/choroid
 - All other parameters changed (ciliary activation, stiffness of other components, etc..
- shape treatment simulations: baseline model with regionally "treated" sclera stiffness

 - treated different area shapes (w/o changing attachment)? treated stiffness: modulus of elasticity (E) = 1.61 MPa, equivalent to ~30 years old*
 - effective stiffness in each zone determined by amount of shape area in each zone

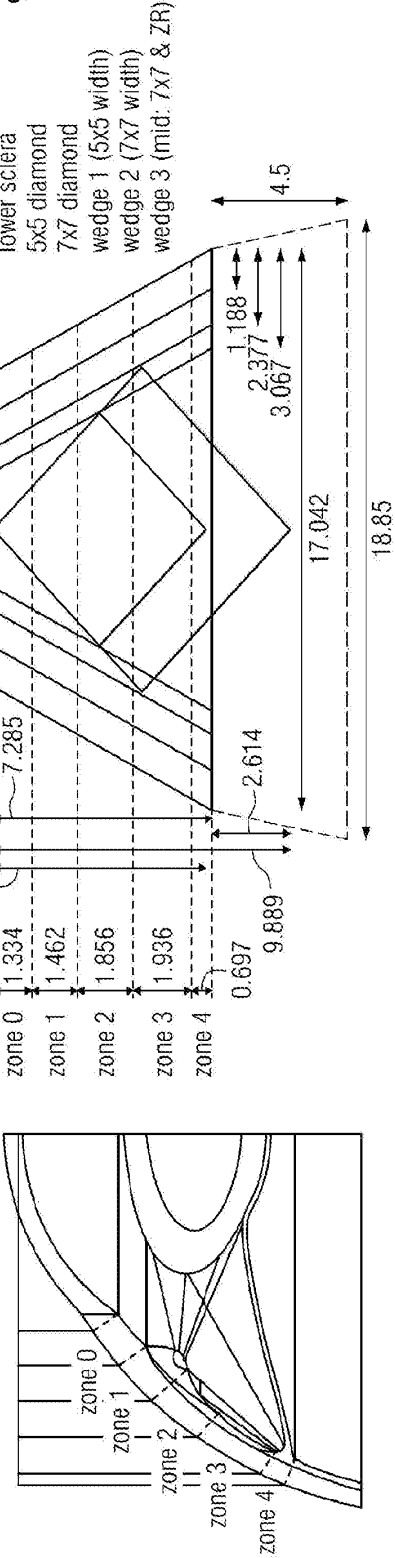


Fig. 99: Different treatment region shapes applied to one sclera Anterior zone quadrant with reference to 5 critical zones

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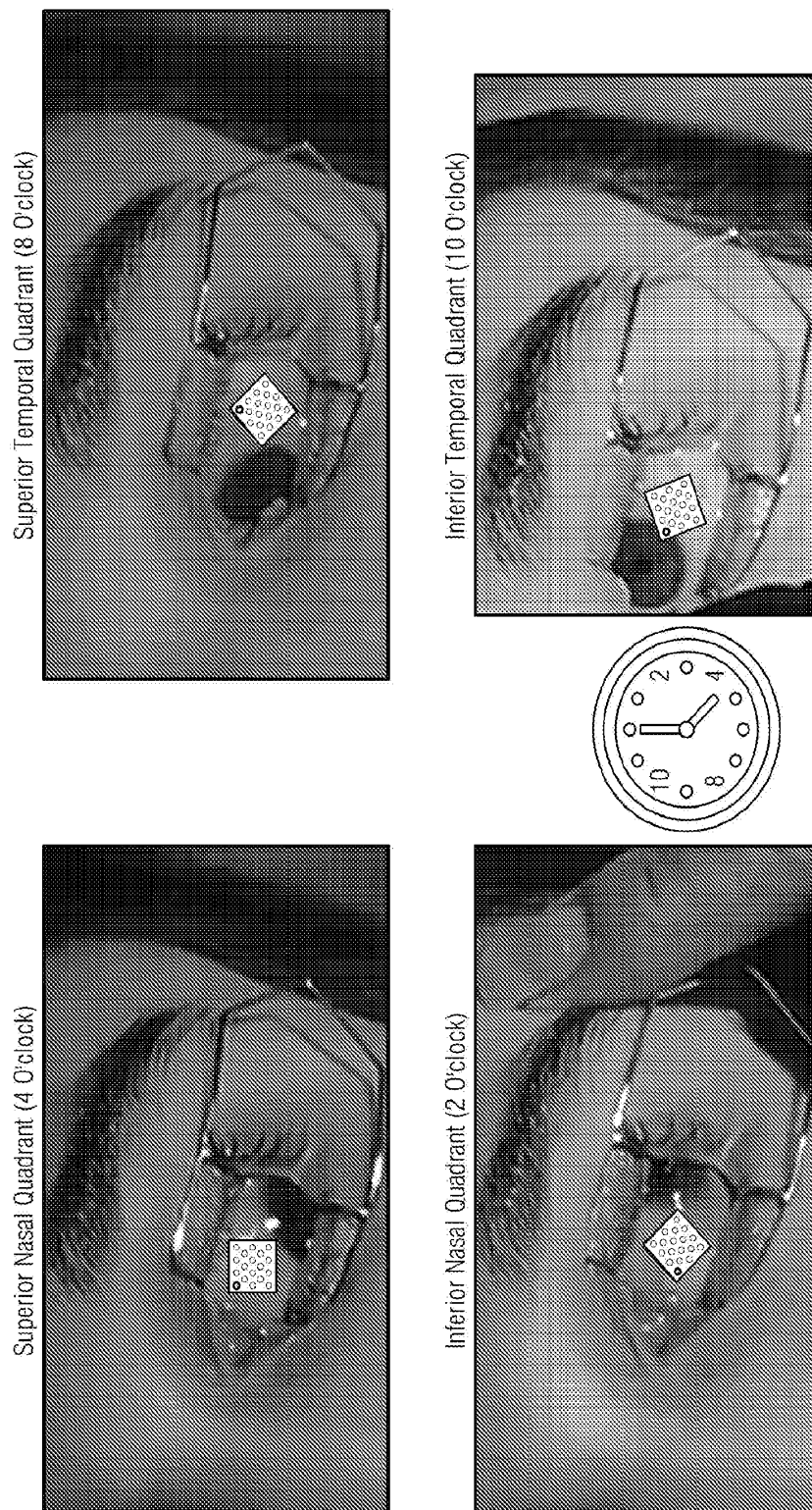


Fig. 100: Four Quadrant Treatment Positions
for right eye referenced around the limbus

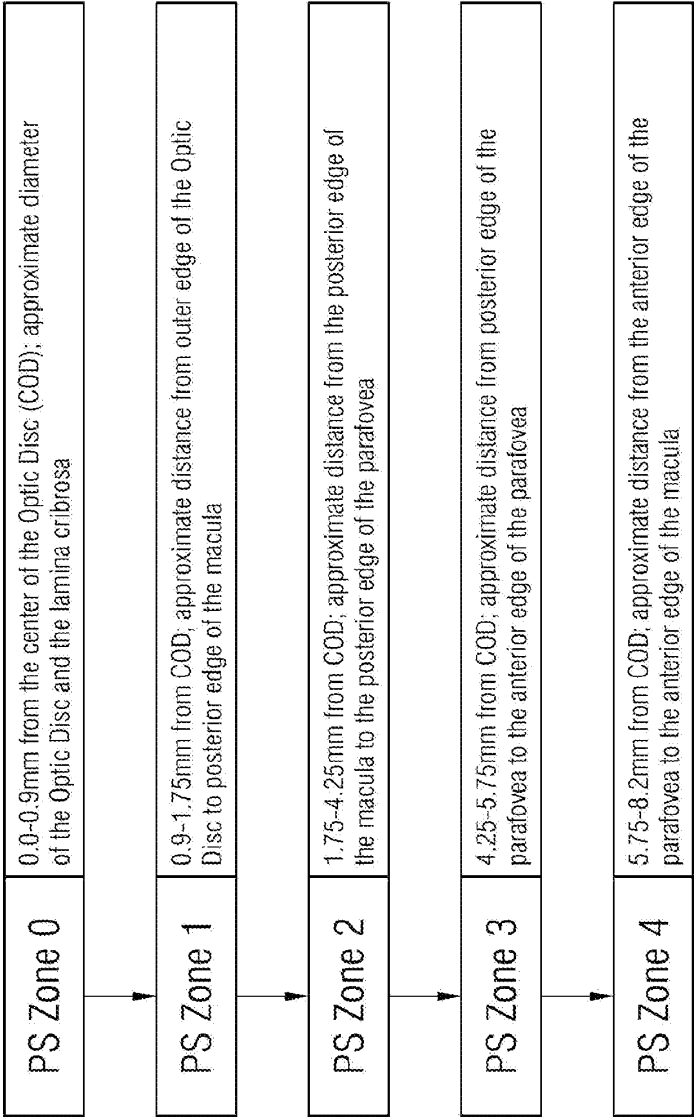


Fig. 101: Posterior Segment Critical Zones Description

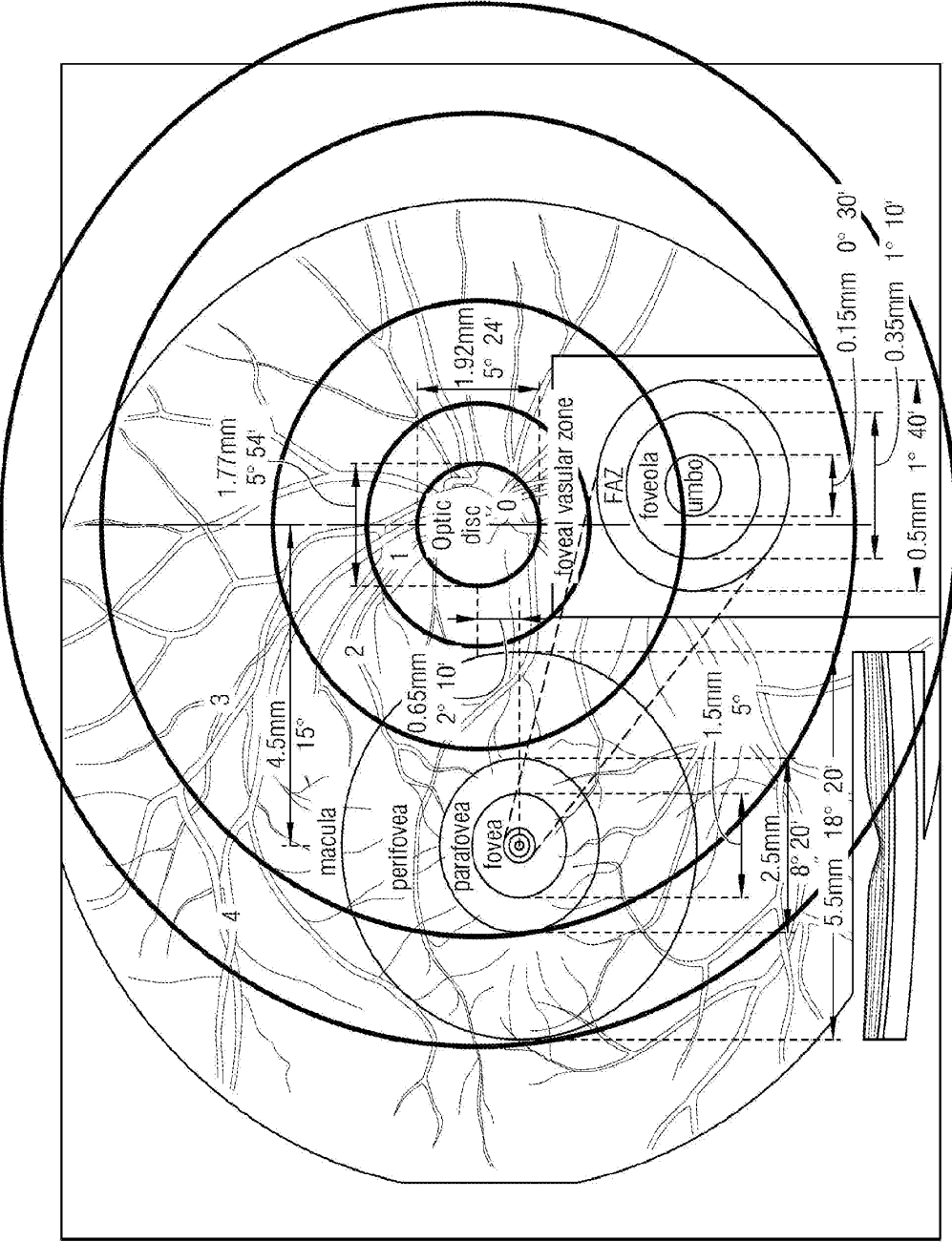
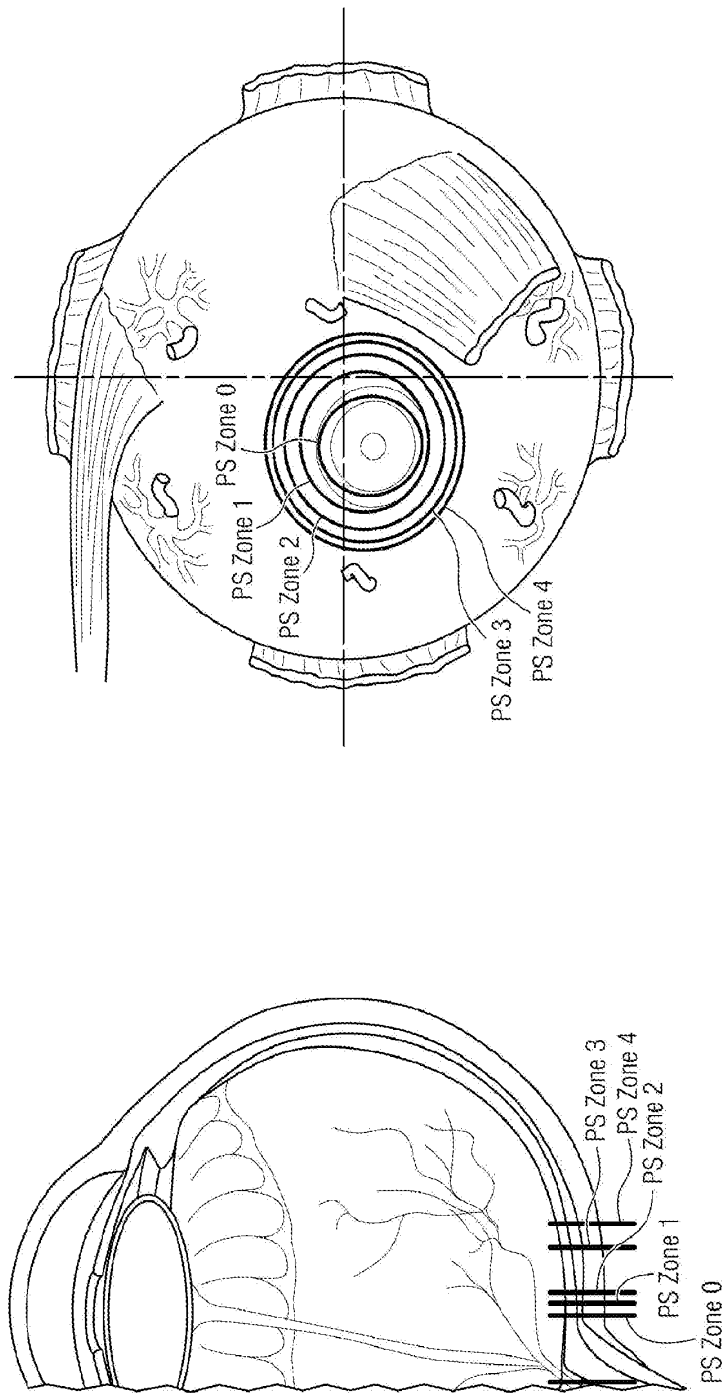


Fig. 102: Posterior Segment 5 Critical Zones

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Drawing of the posterior eye. T, temporal; N, nasal. The optic nerve (a) with its central vessels and surrounding meningeal sheaths is seen. Its center is located 3 mm nasal and 1 mm inferior to the posterior pole of the eye. Surrounding it are the short posterior ciliary arteries and nerves. The approximate position of the macula is at x. Along the horizontal meridian, which bisects the eye, are the long posterior ciliary arteries and nerves (b). The exits of four vortex veins are shown, one for each quadrant (c). The curved, oblique insertions of the superior oblique (d) and inferior oblique (e) muscles are seen. The cut ends of the four rectus muscles are at f. (Hogan M, Alvarado J, Weddell J: Histology of the Human Eye—An Atlas and Textbook. Philadelphia: WB Saunders, 1971:51)

Fig. 103: Posterior Segment 5 Critical Zones

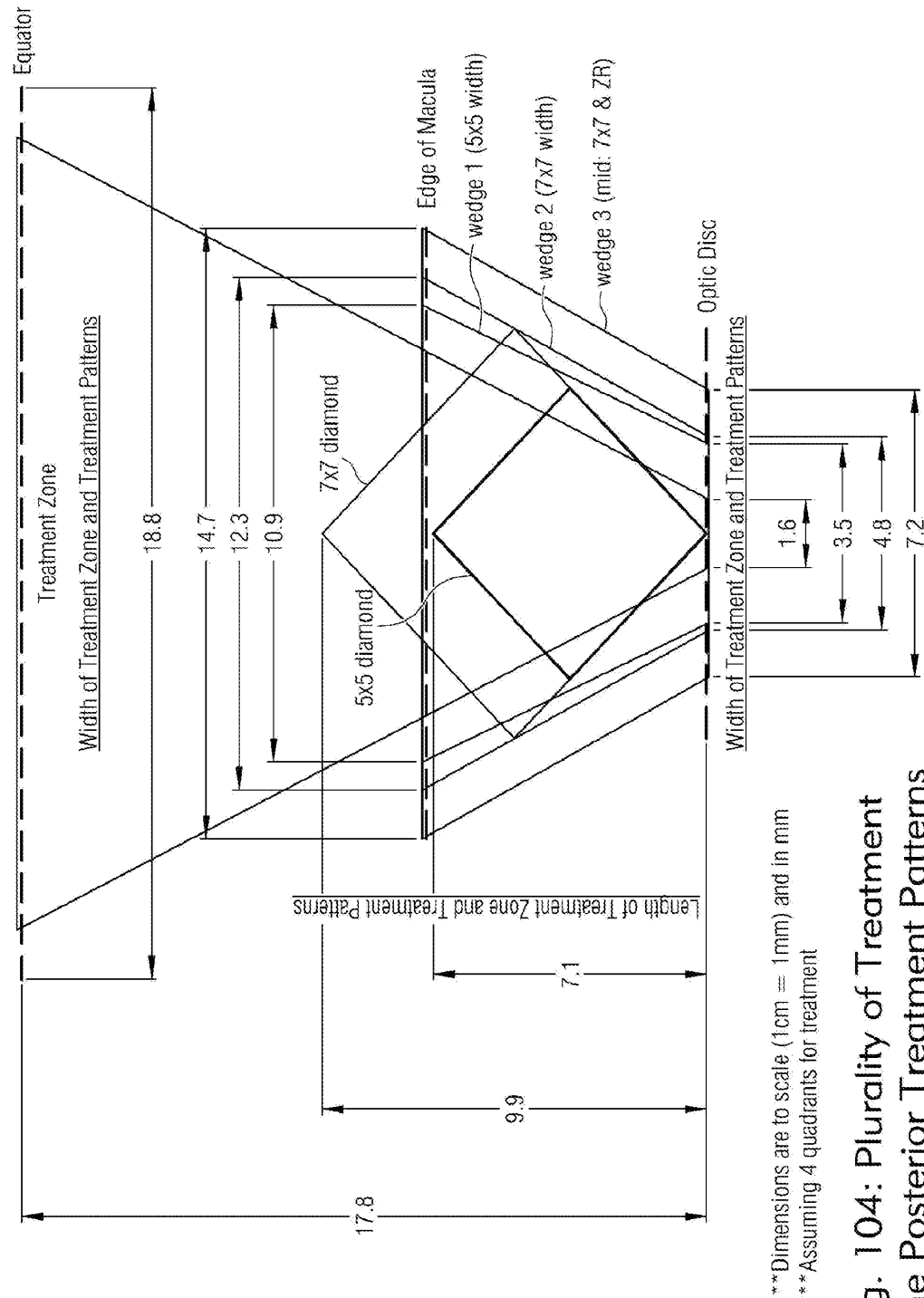
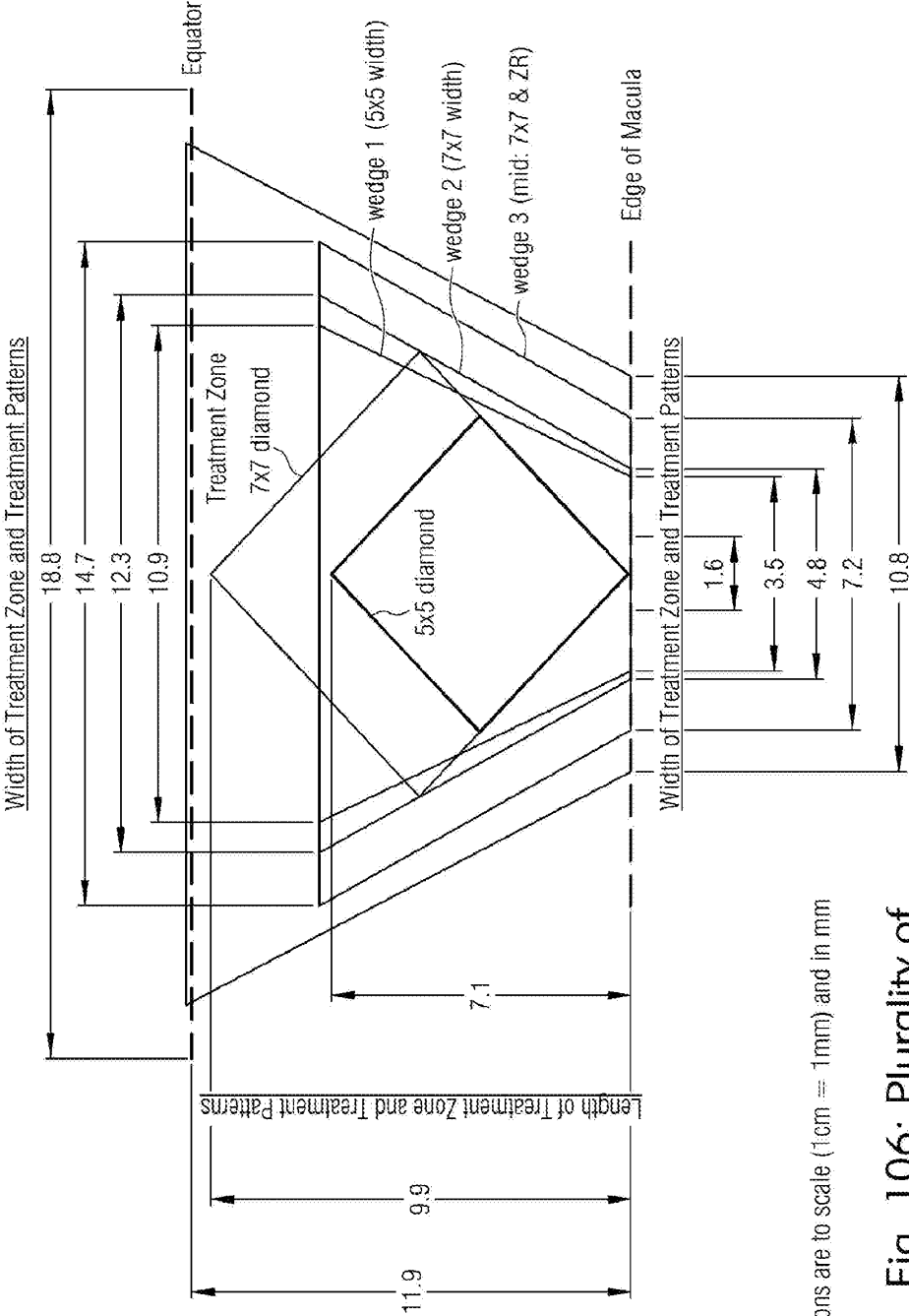
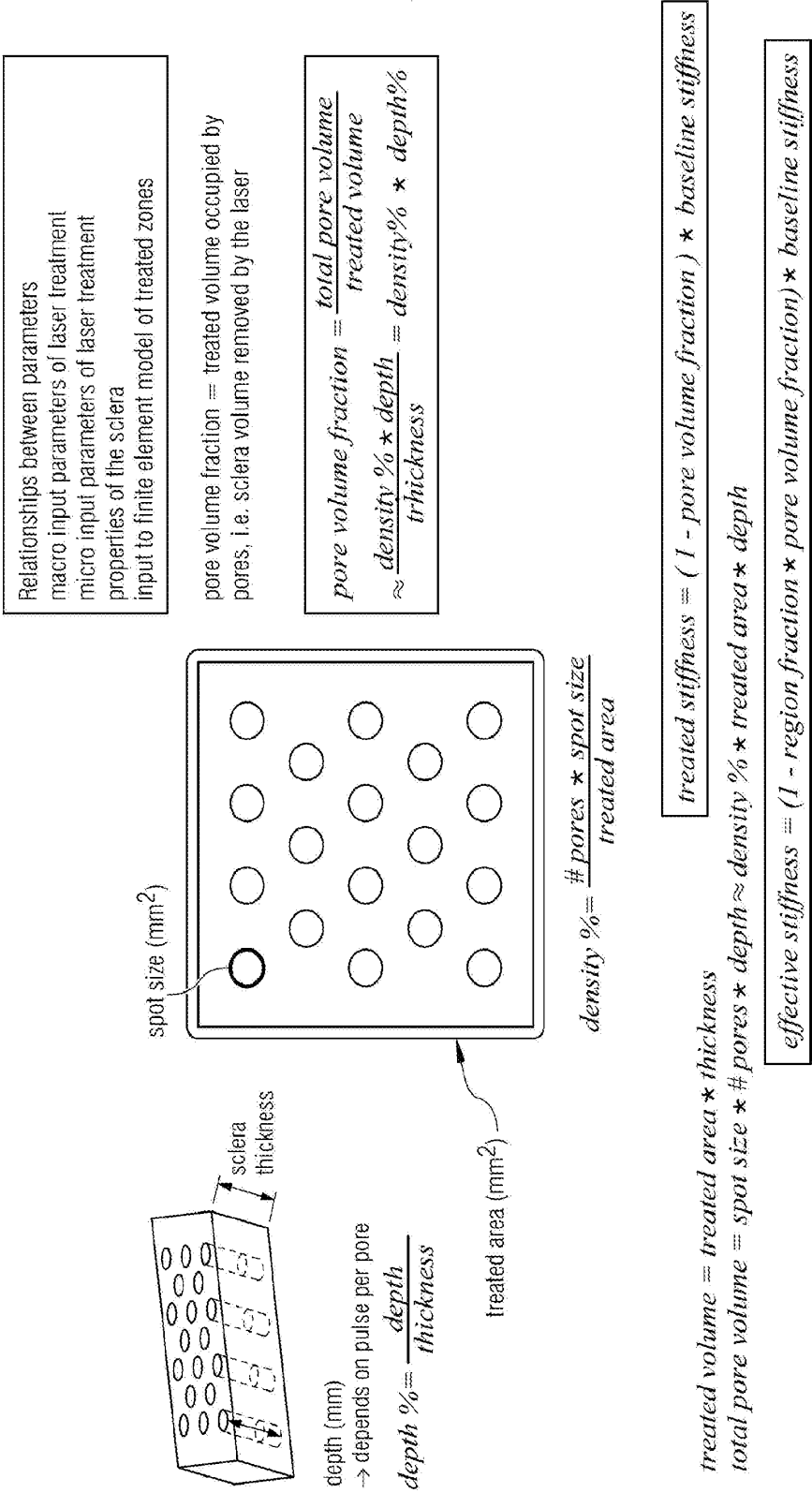


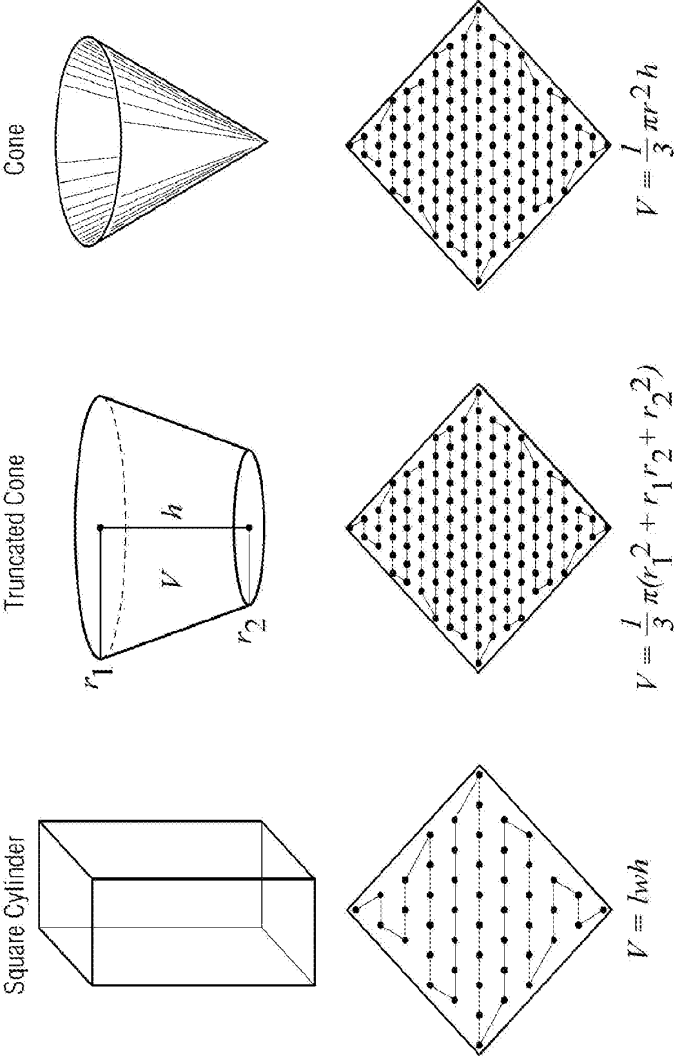
Fig. 104: Plurality of Treatment Zone Posterior Treatment Patterns



**Dimensions are to scale (1cm = 1mm) and in mm

Fig. 106: Plurality of Treatment Patterns





- A cone (or truncated cone) is 1/3 the volume of a cylinder (square or circle)
- To achieve the same pore volume fraction with a cone:
 - Increase pore depth
 - Increase pore surface area
 - Increase number of pores

Fig. 108: Pore Volume Fraction Depends on Shape

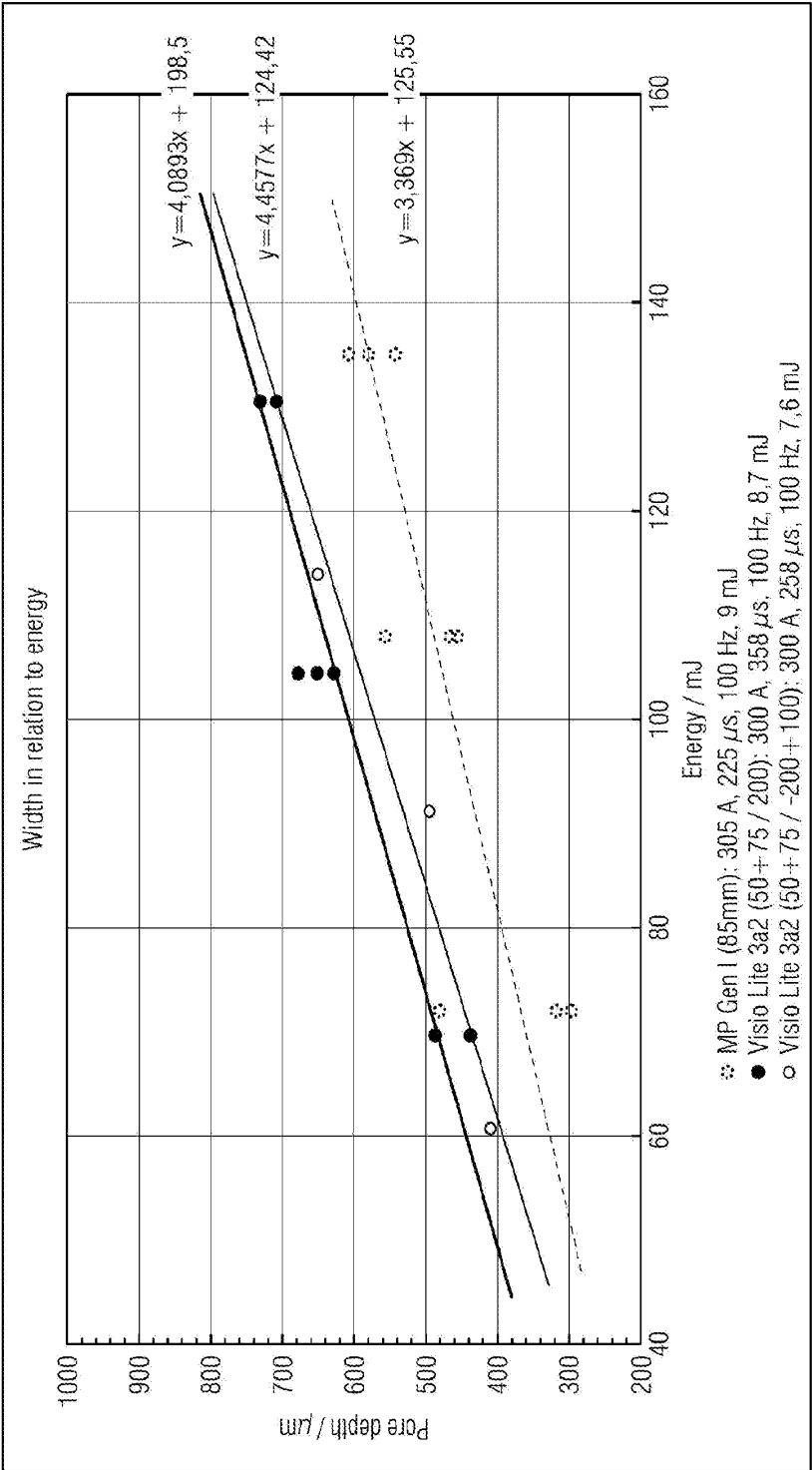
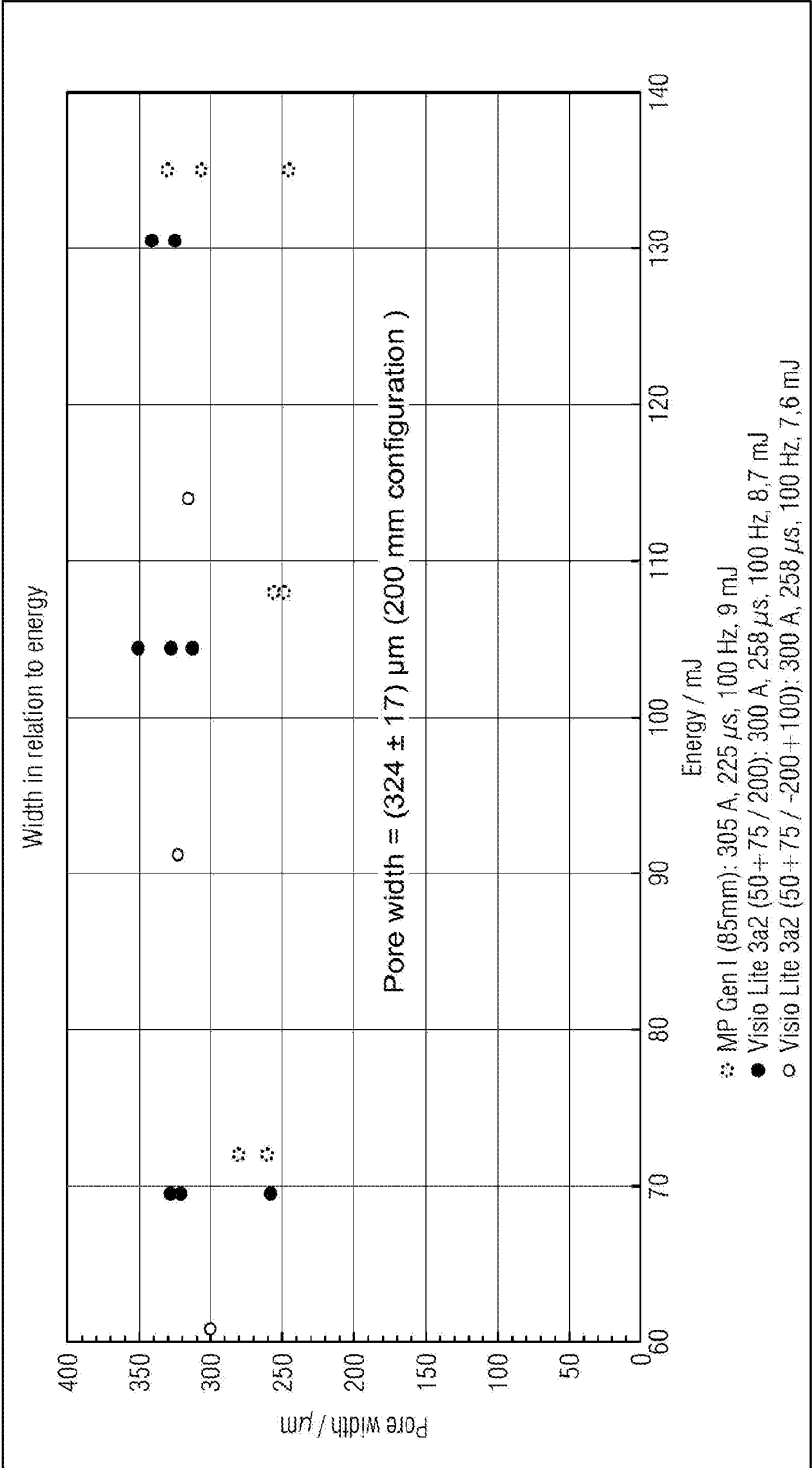


Fig. 109: Pore depth plotted in relation to total energy per pore



Pore Cross section size (width or diameter) stays the same when increasing the energy per pore.

Fig. 110: Pore width plotted in relation to total energy per pore

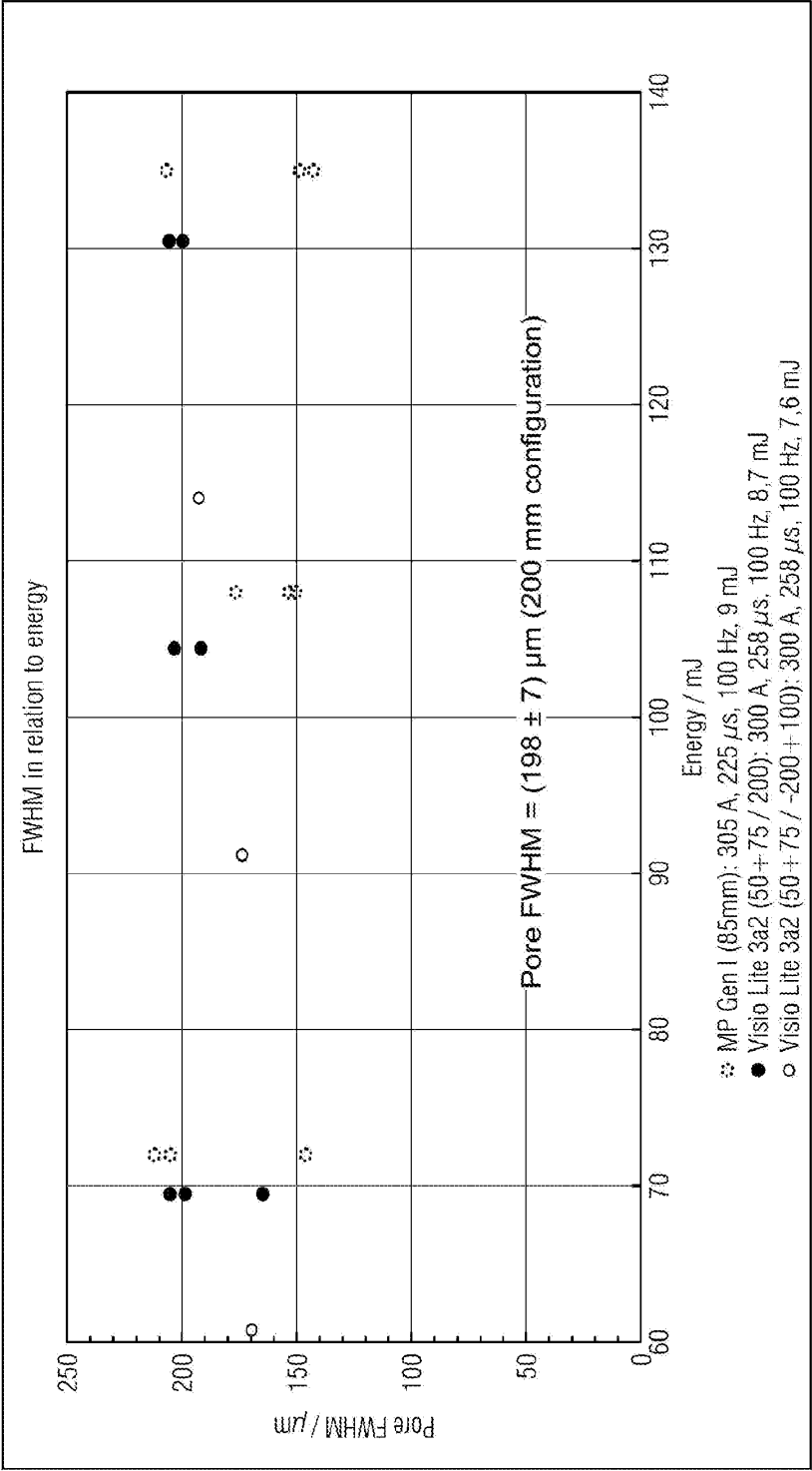


Fig. 111: Pore FWHM plotted in relation to total energy per pore

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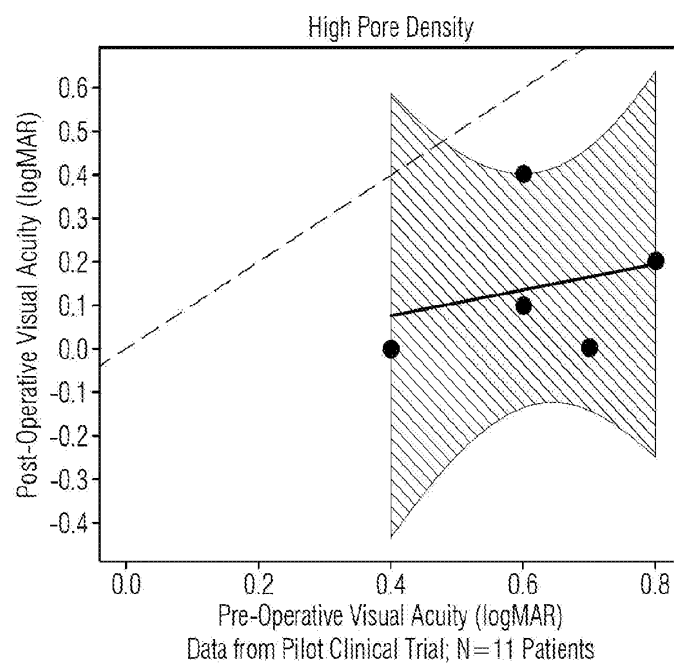
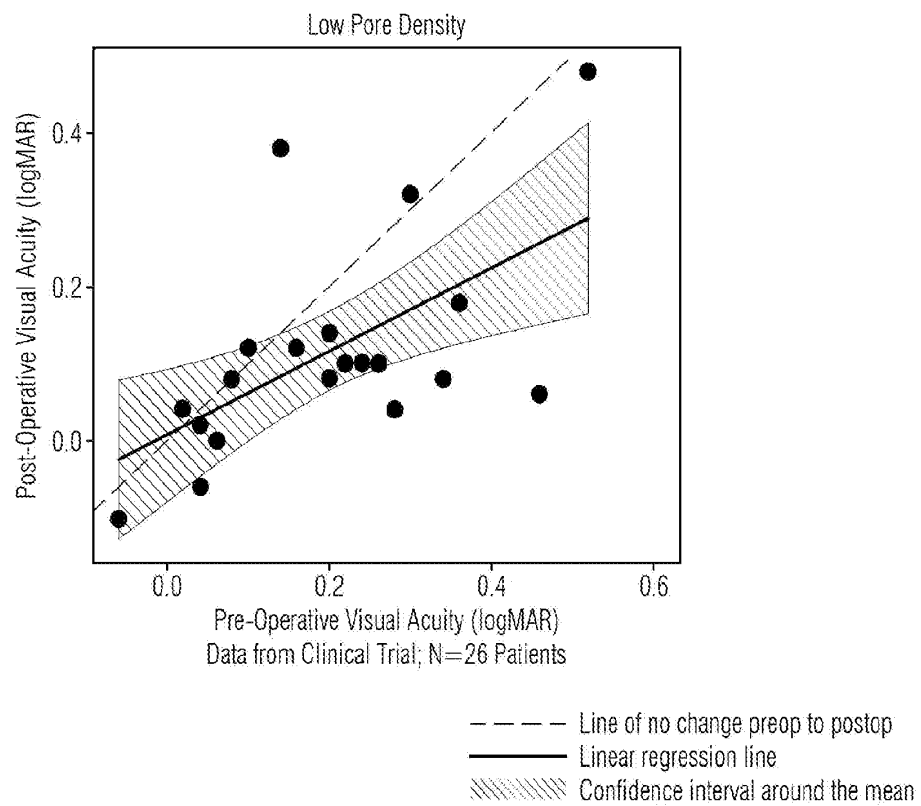
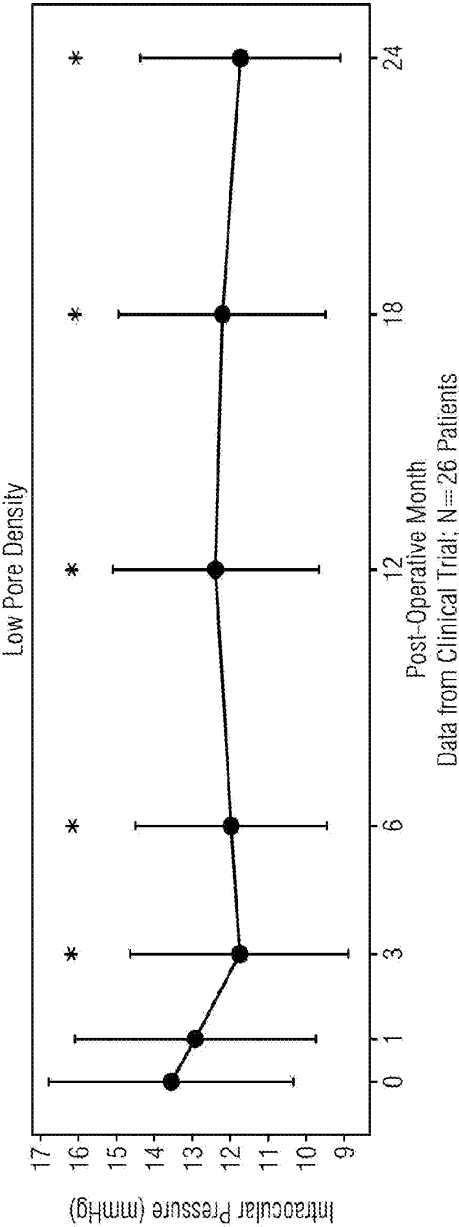


Fig. 112 - Visual Acuity Comparisons

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Figures show mean +/- standard deviation
* Denotes significance compared to PreOP
Note the difference in scales

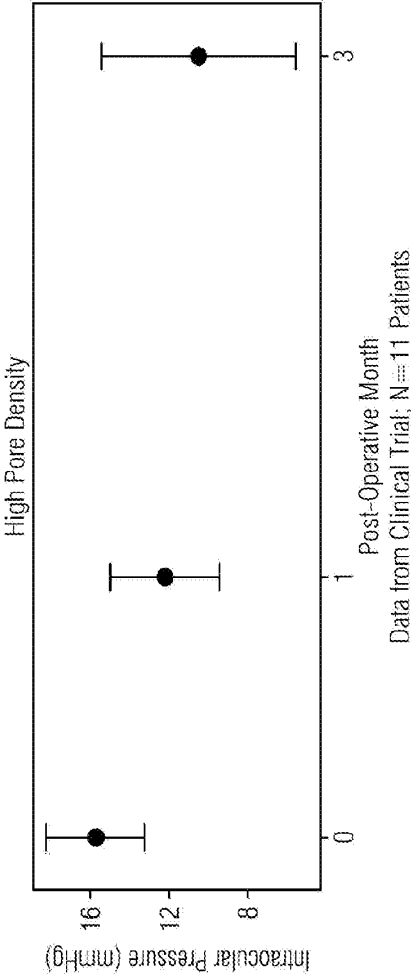


Figure 113: Intraocular Pressure (IOP) Comparison

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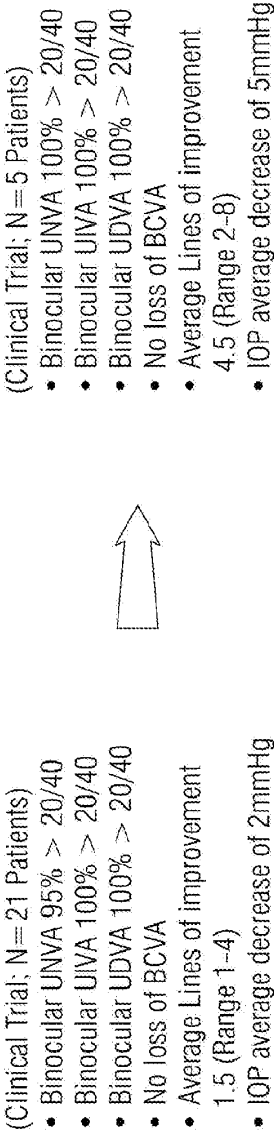
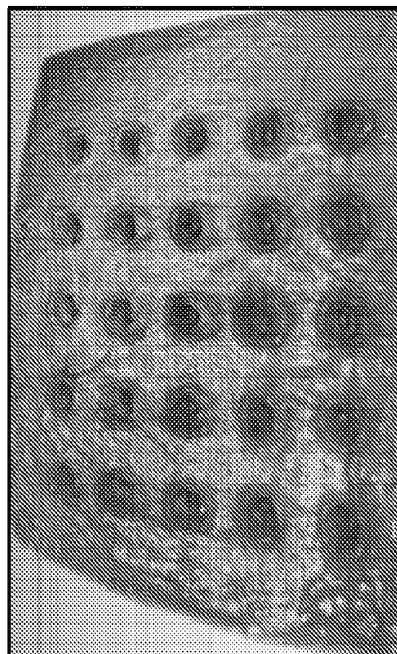
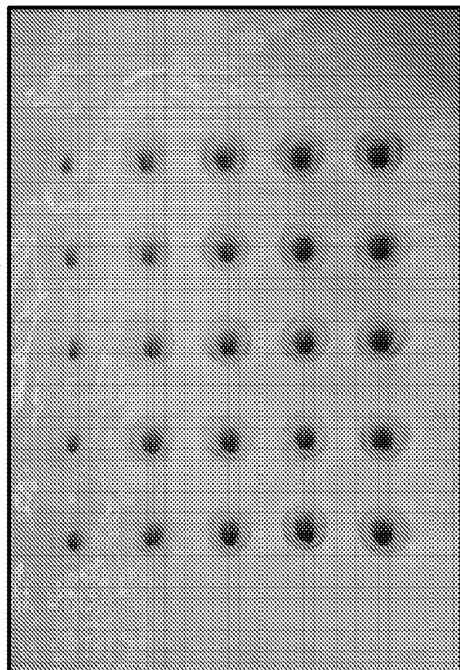


Figure 114: Compare Innovation Improvement in Visual Acuity and IOP

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• (High Pore Density)



• Hoya: Low Pore Density

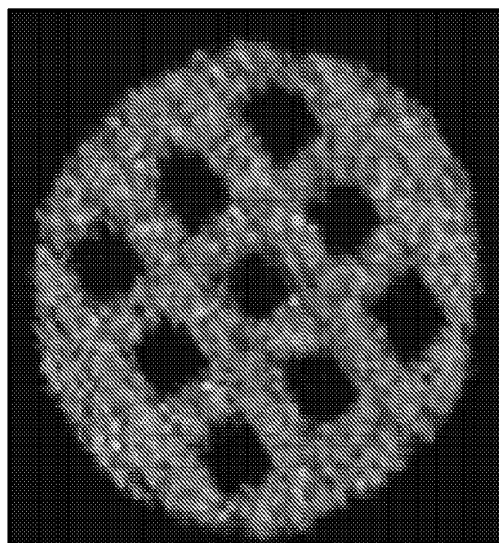


Figure 115: Hoya Low Density System vs High Density

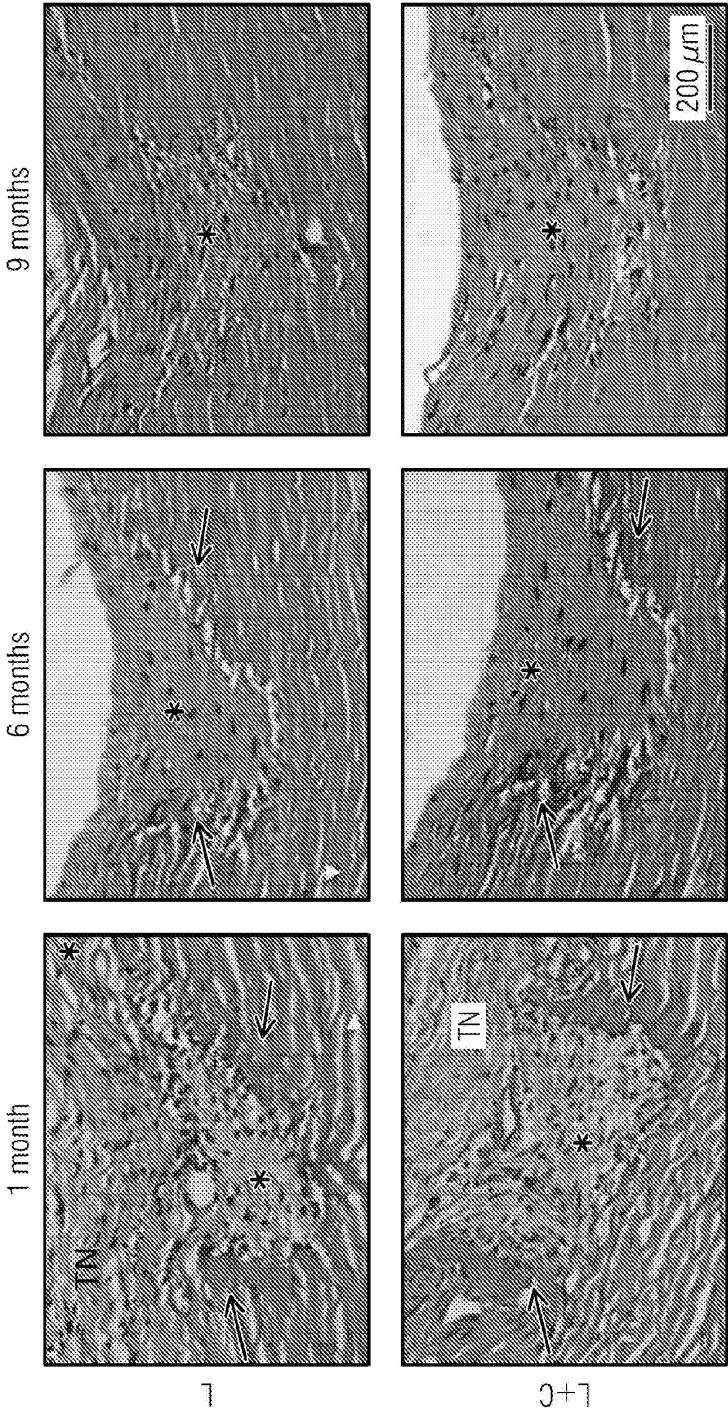


Fig. 116: Histology of Micropores

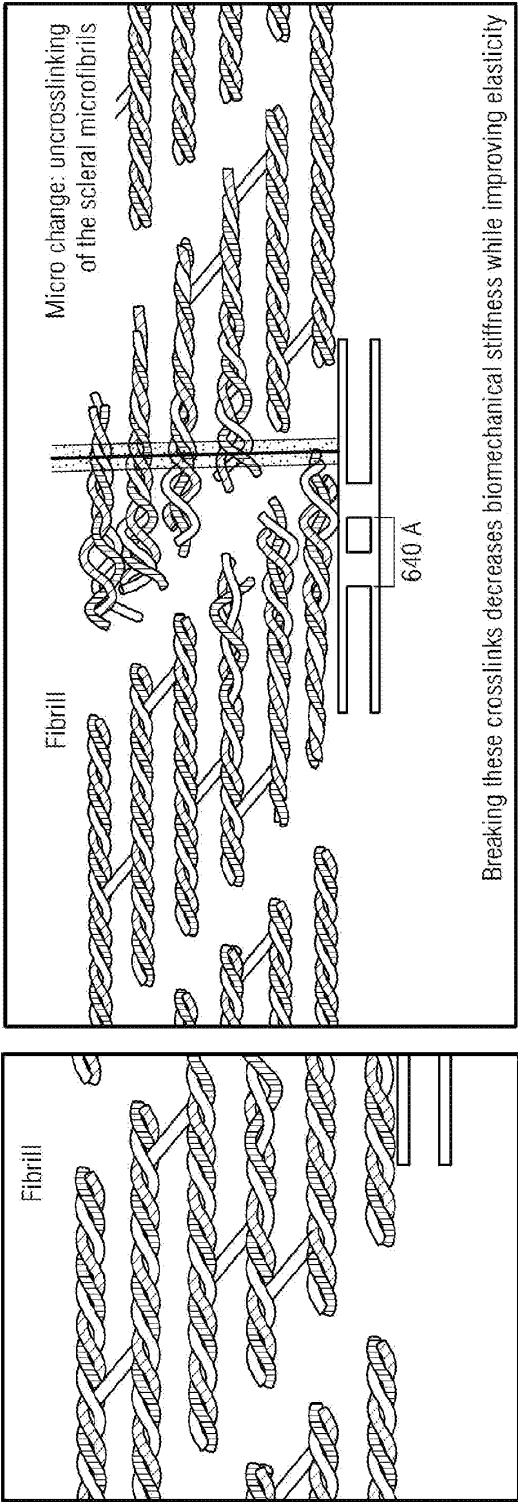


Fig. 117: Un-crosslinking: Breaking of Bonds →
Decreased Biomechanical Stiffness (Compliance)

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Treatment laser beam ablation of individual pores

Un-crosslinking is breaking bonds in microfibrils and fibrils. It weakens tissue or allows tissue to be more compliant.

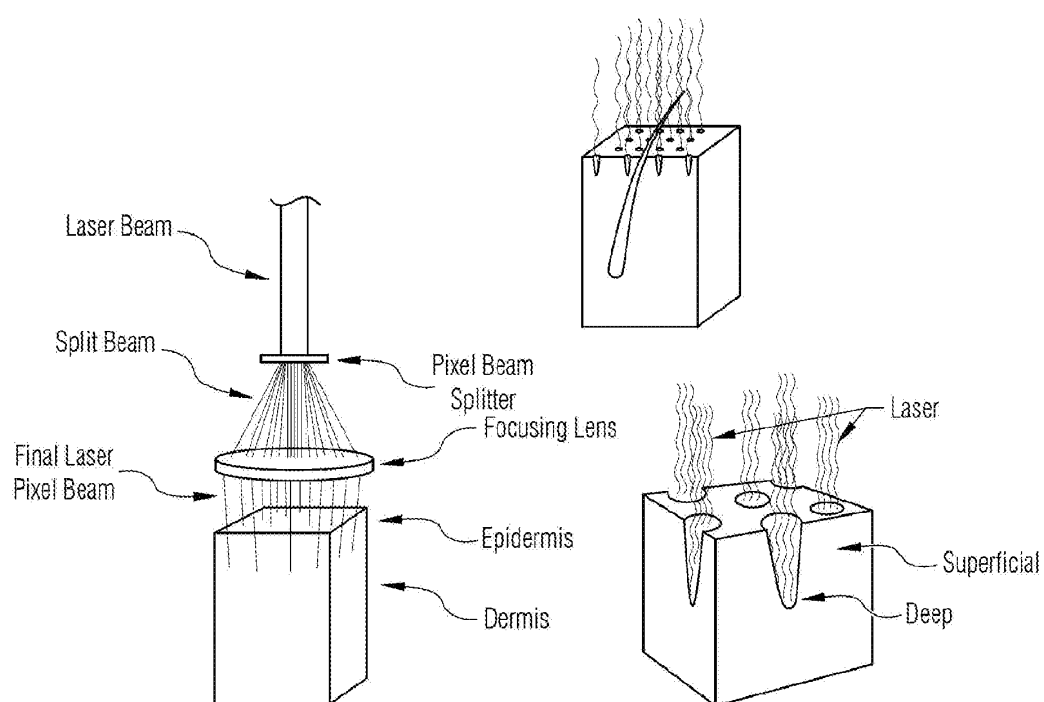


Fig. 118: Laser Un-crosslinking Scleral Fibrils & Microfibrils

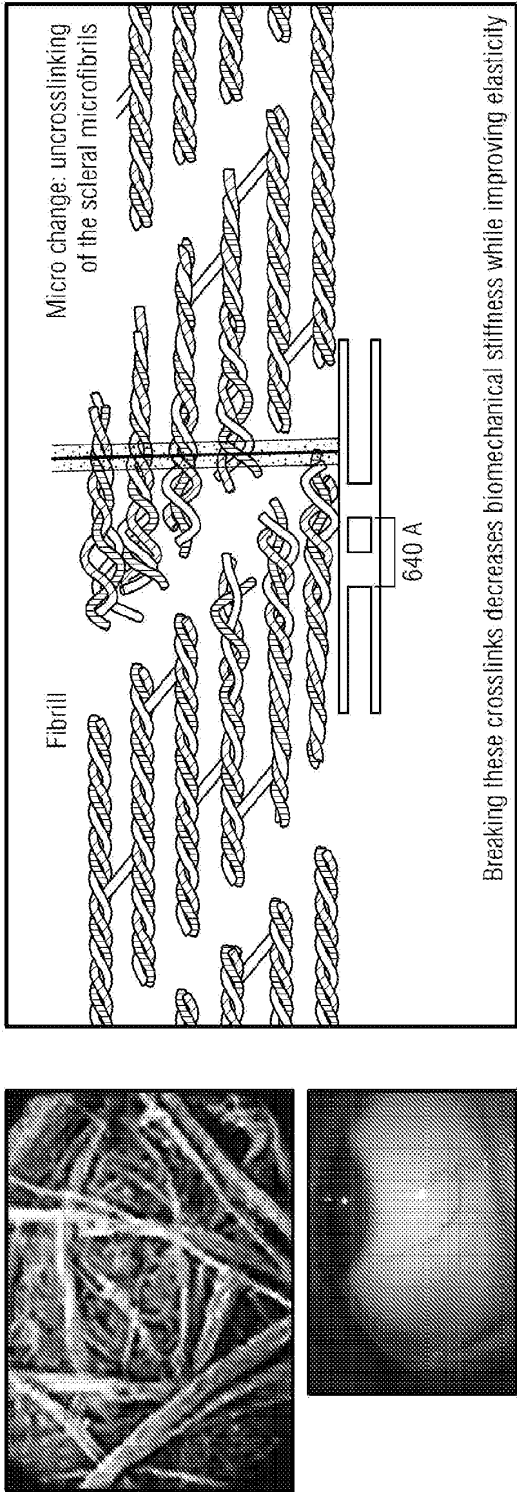
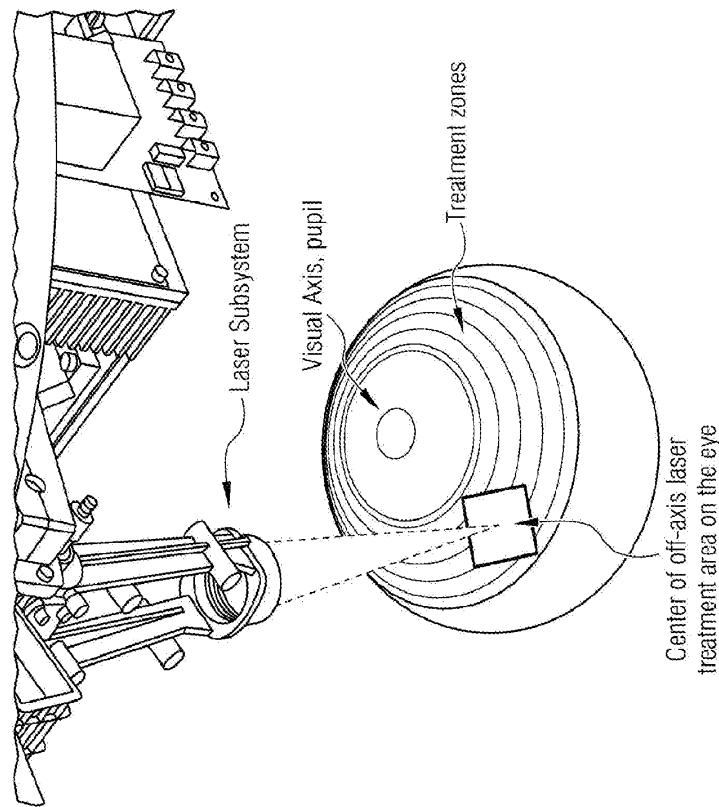


Fig. 119: Laser Scleral Microporation:
SubSurface Bond Breaking maybe change word from "subsurface ablation" to "subsurface bond breaking" within the pore cylinder. Uncrosslinking Breaking Bonds → Decreased Biomechanical Stiffness



- In the simplest view the motion control moves the treatment laser as shown on slide 21 around the patient's eye on the surface of a dome.
- The dome is positioned in the x, y and z axis to align with the initial microprobe position of the treatment protocol and then step around the dome to the next microprobe position.
- The x, y and z axis is not changed over the treatment of one quadrant but will need to be modified for another quadrant.

Dome with Laser Head Unit
optical axis pointing to center of
the treatment area

Figure 120: Treatment Dome Off Axis Laser pointing Concept

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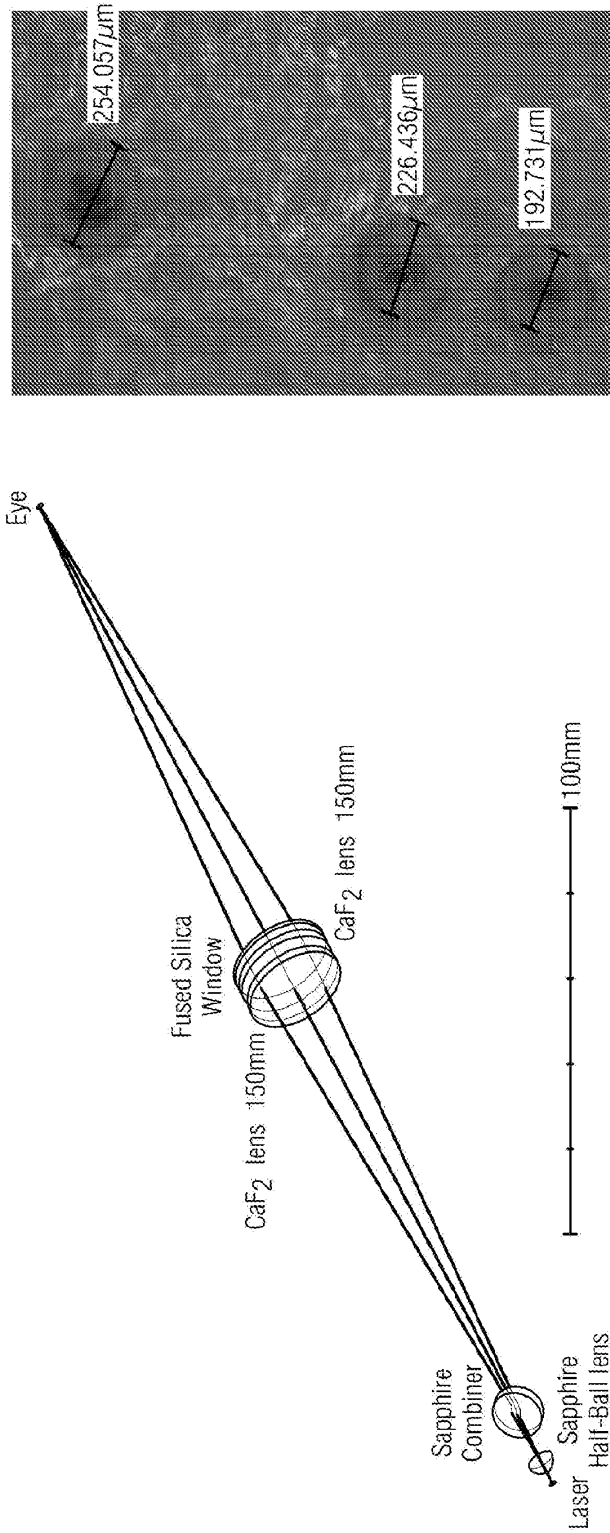


Fig. 121: Optical configuration - Spherical CaF₂: 150/150

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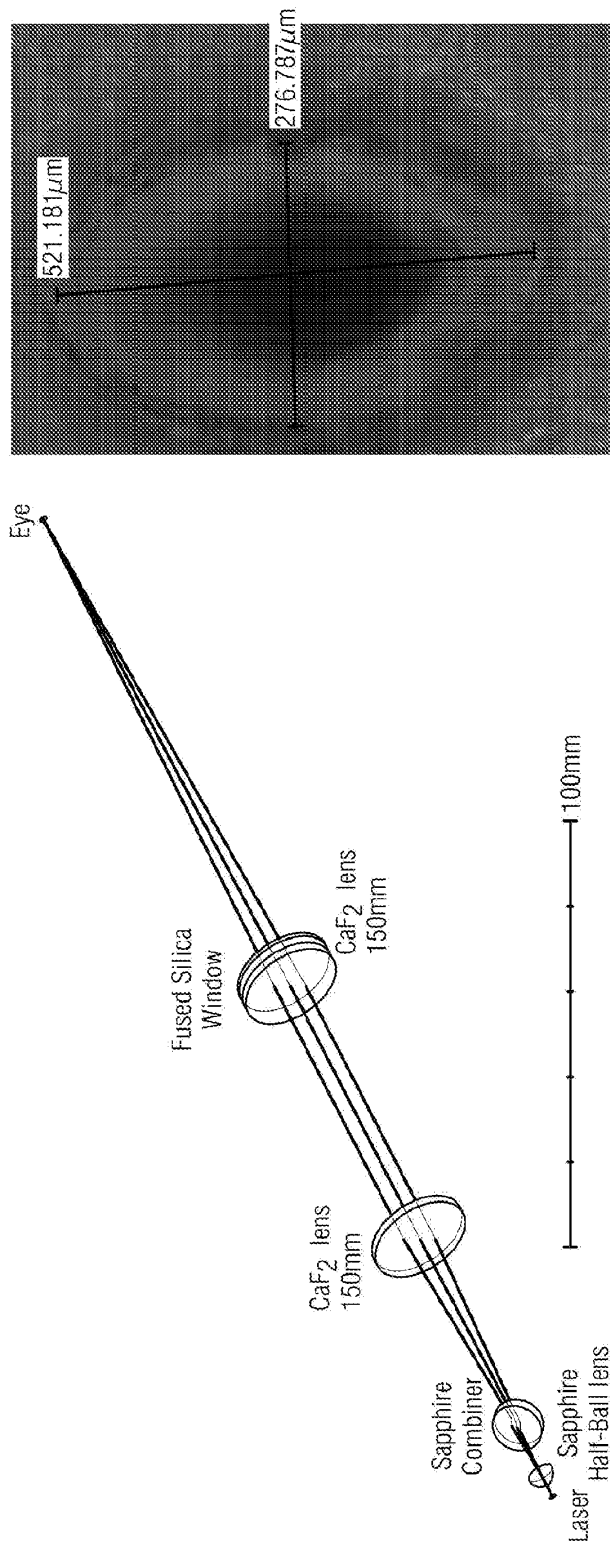


Fig. 122: Optical configuration - Increased focus size: Spherical CaF₂ : 75/150

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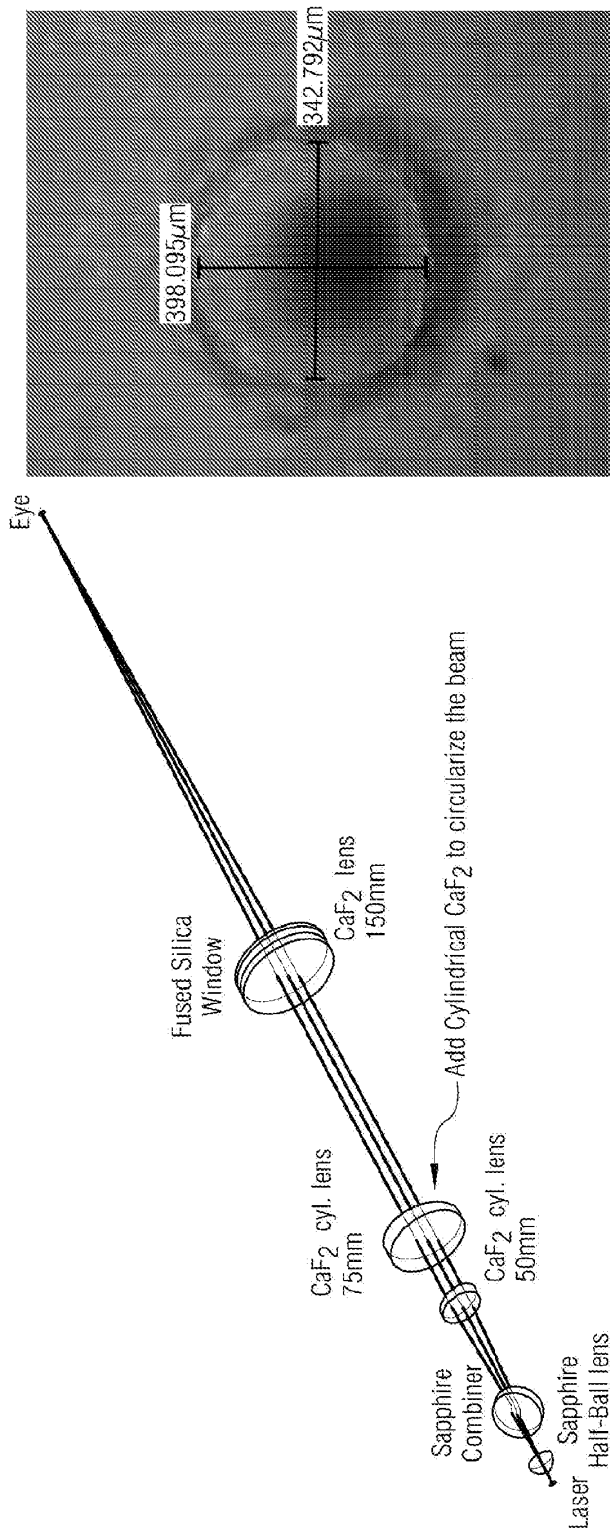


Fig. 123: Optical configuration - Circularization of the focus: Cylindrical CaF₂ : 50/75/150

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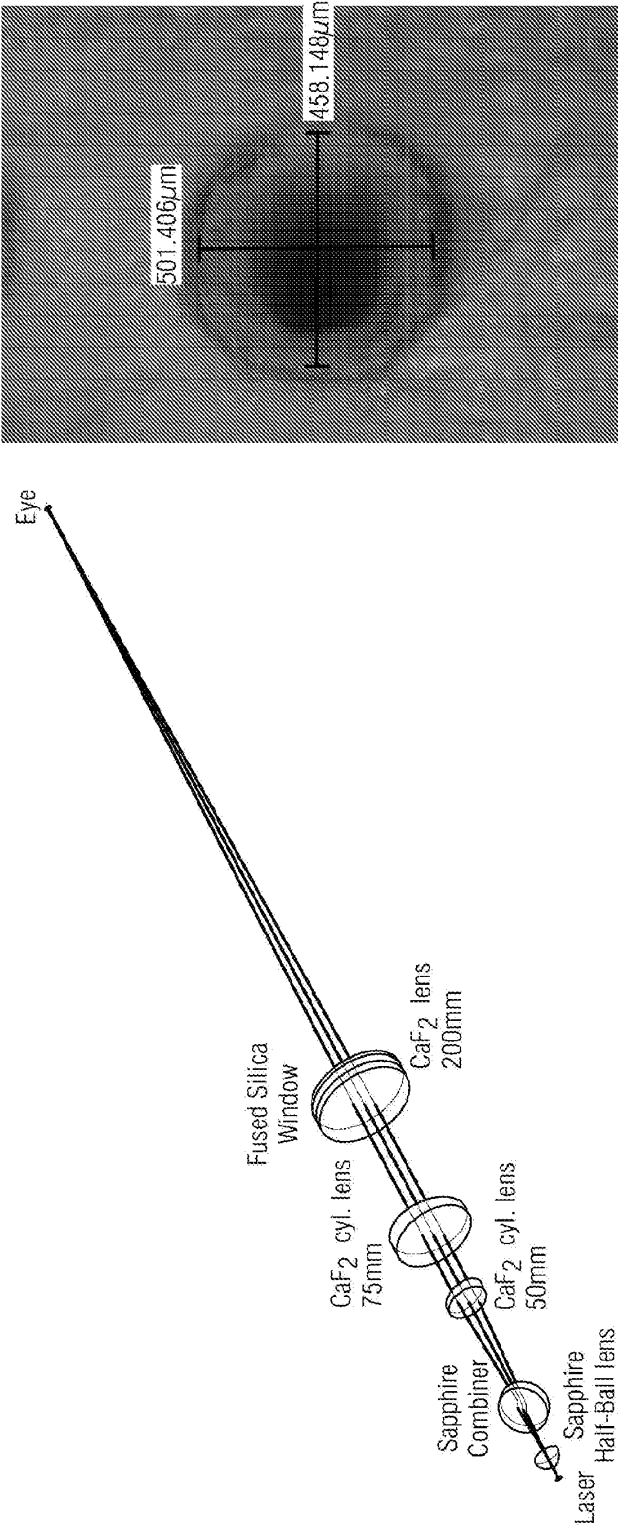


Fig. 124: Circularization & Increase of the beam focus: Cylindrical CaF₂ : 50/75/200

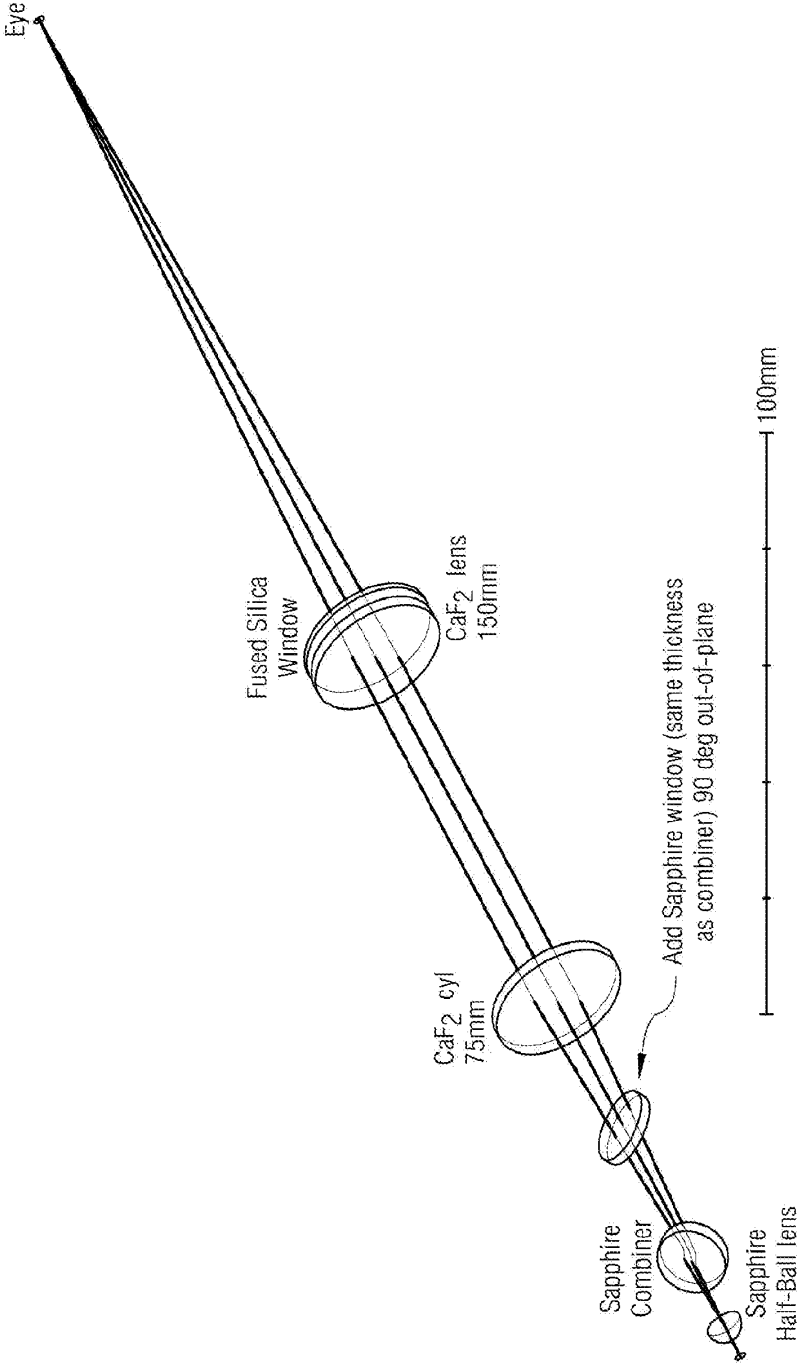
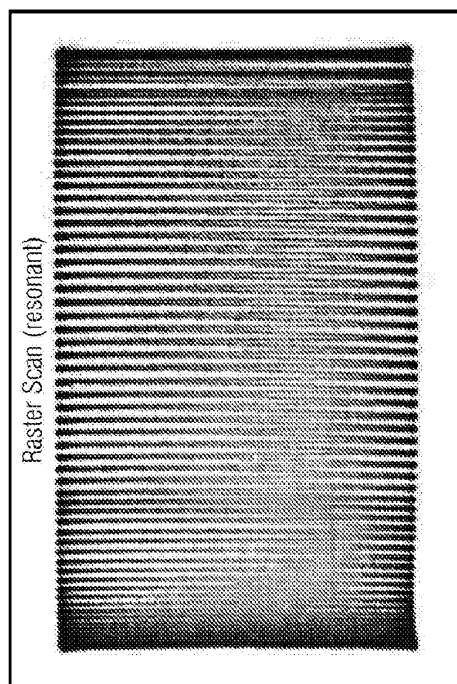


Fig. 125: Alternative concept with polarization correction window added

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- Required Performance:
- Mechanical scanning angle
 $\sim 2^\circ$ (full angle)
 - Angle required for $60\text{ }\mu\text{m}$ step
 $\sim 420\text{ }\mu\text{rad}$
 - Required line speed for 2° mech.
 $> 50\text{ Hz}$
 - Required lines for $10 \times 10\text{ mm}^2$
 ~ 160 line scans
 - Speed for a full scan
 < 4 seconds

Fig. 126A: Optical System with Scanner Mirror
 capabilities - one axis is operated RESONANT (MR-15-30)

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Actuator Type	4-Quadrant (2 axis, bi-directional)	
Mechanical tilt angle DC	± 25 X axis; ± 25 Y axis	$^{\circ}$
Mechanical tilt angle dynamic	± 25 X axis; ± 25 Y axis	$^{\circ}$
Mirror diameter	15	mm
Center of rotation to mirror surface	1.3	mm
External diameter	35.4	mm
Height	14.5	g
Weight	29.3	ppm/ $^{\circ}$ C (Max)
Scale drift	T.B.D	μ rad/ $^{\circ}$ C (Max)
Zero drift	25	μ rad
Resolution (closed loop)	<5	μ rad
Repeatability RMS (typical)	30-100	Hz
Full scale bandwidth	20	
Sine wave ($+25^{\circ}$)		Hz
Small signal badwidth ($< +0.1^{\circ}$)	350	ms
Large angle step response (20° step)	7.5	ms
Small angle step response (0.1° step)	1.4	

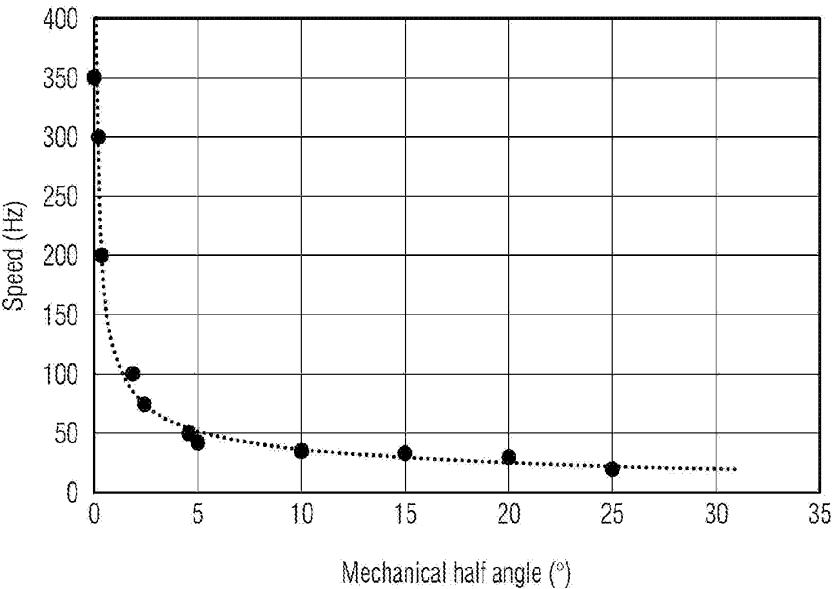
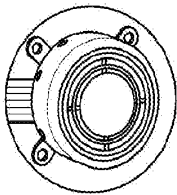


Fig. 126B: Optical System with Scanner Mirror capabilities - one axis is operated RESONANT (MR-15-30)

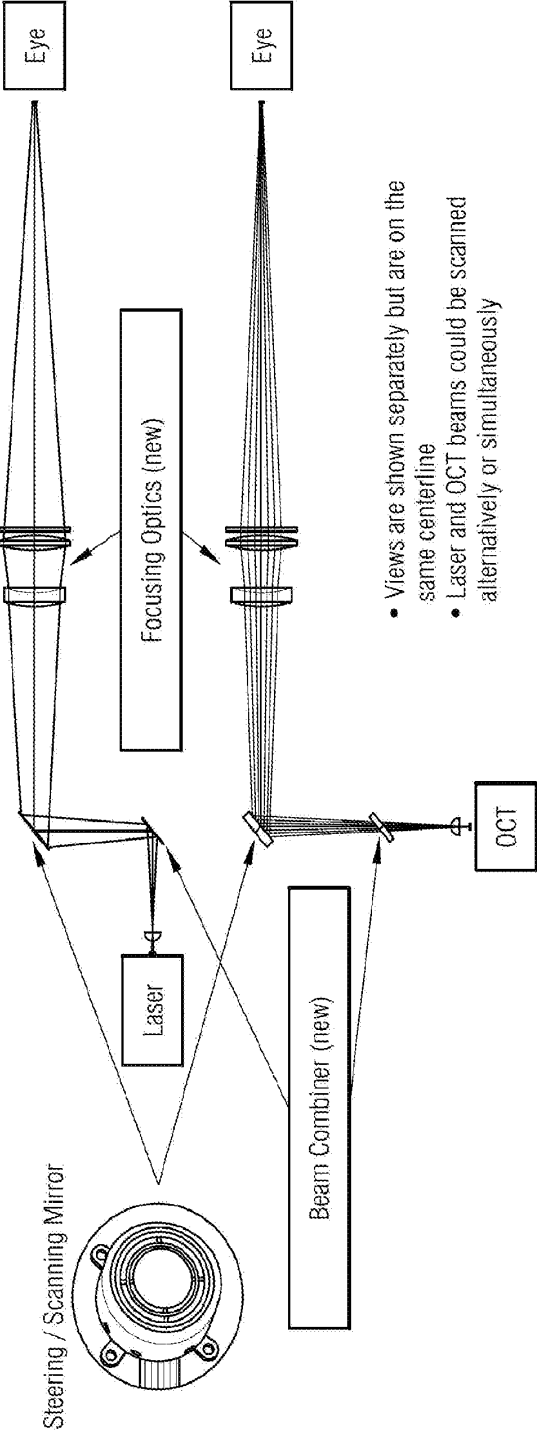


Fig. 127: System with scanning mirror , 5 axis Head, separate Z motion and Real-time OCT/DC with beam splitter

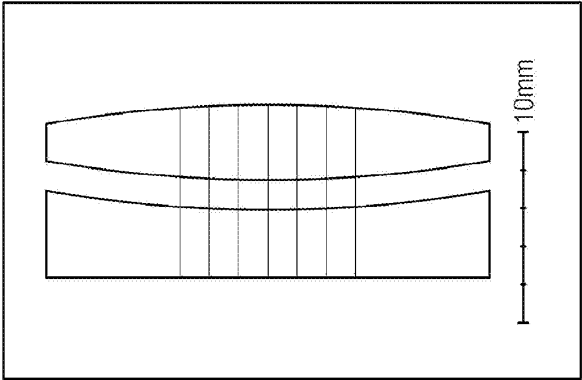
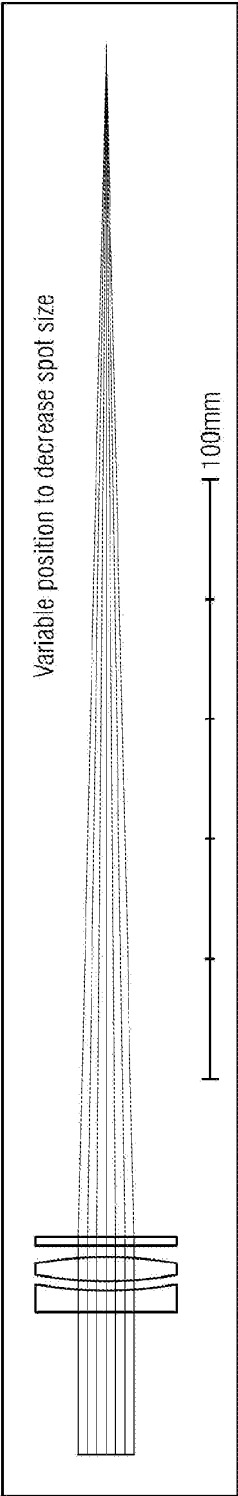
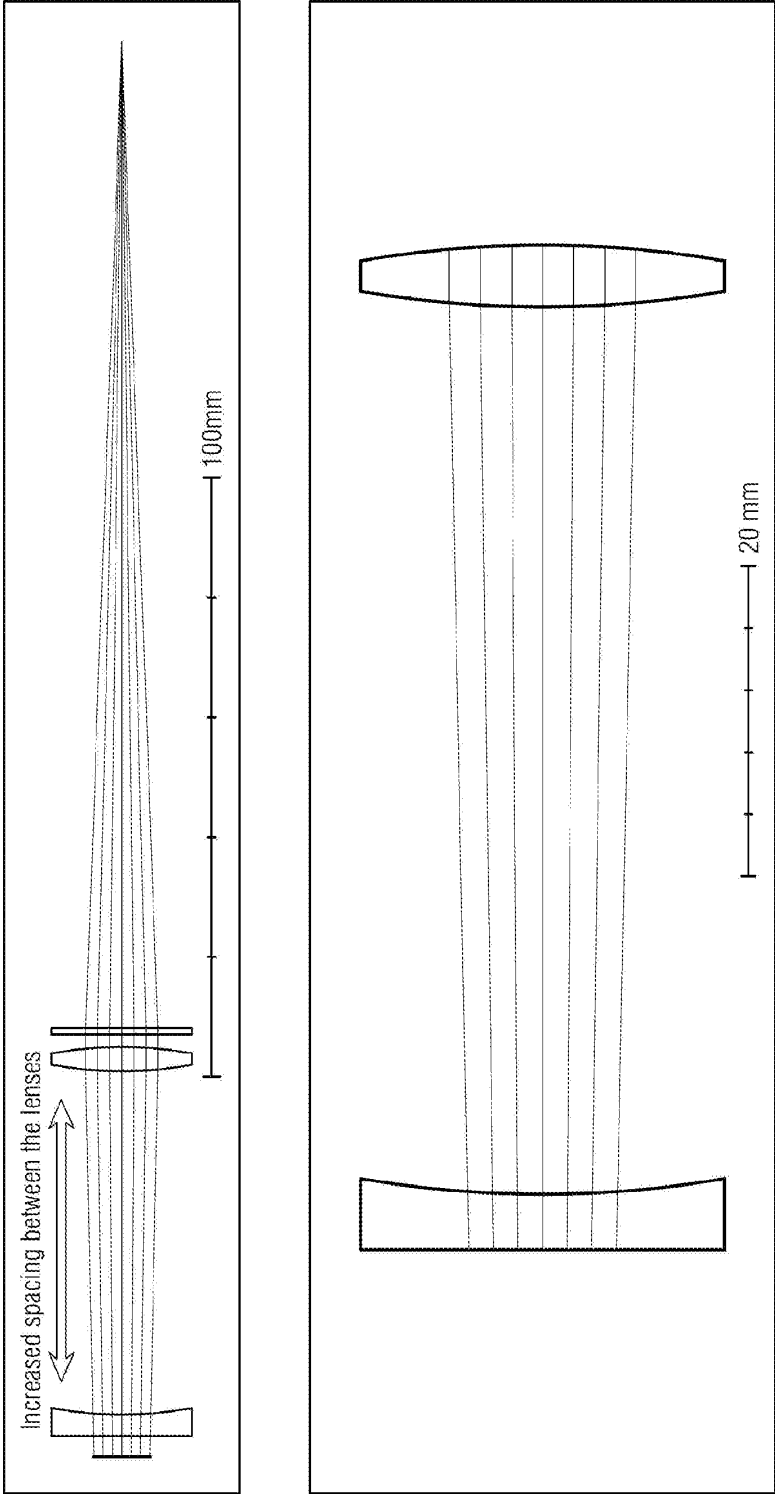
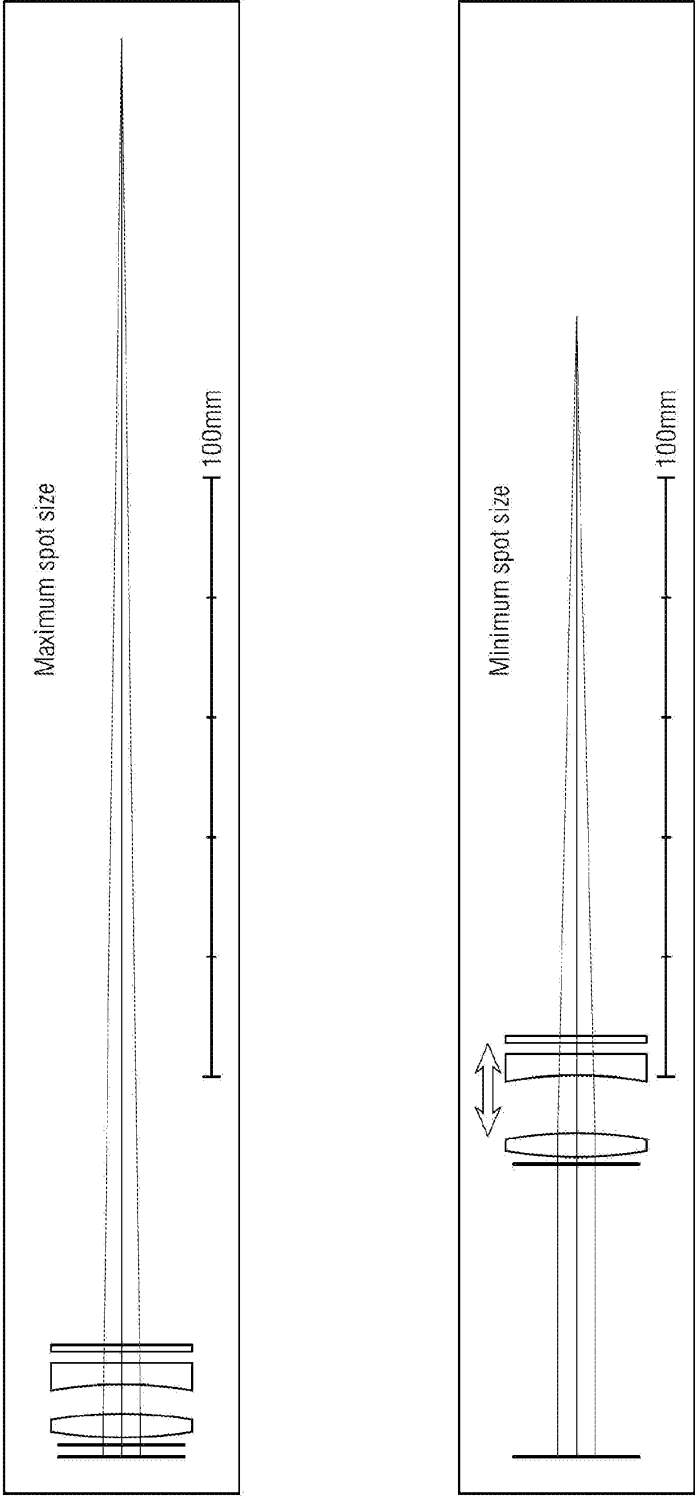


Fig. 128: Optical System with Doublet with overall focal length of 200 mm and 300 μ m beam diameter



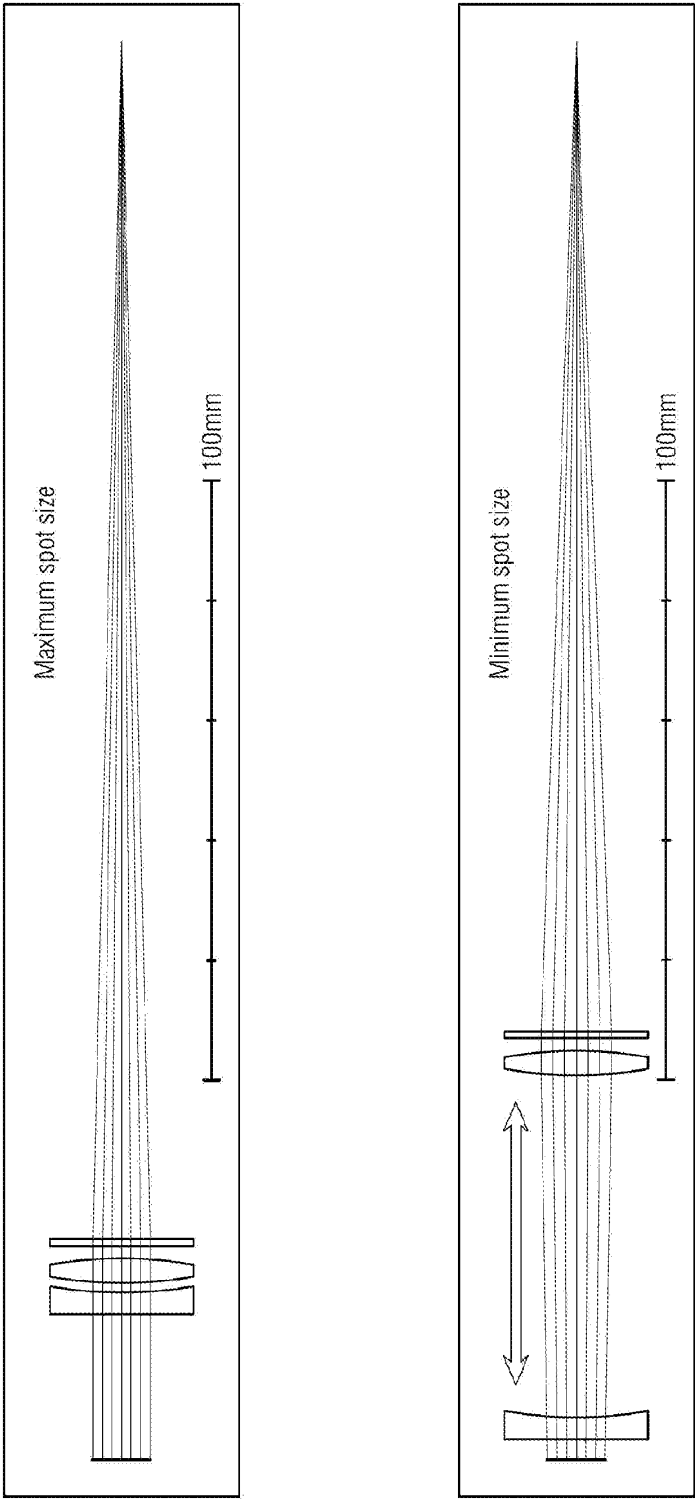
Doublet, zoomed in to about 33% decreased Beam size and working distance.
Resulting spot size is about 200 μm

Fig. 129: Optical System with doublet for zoom spot size with overall focal length of 200 mm and 200 μm beam diameter



Focusing (75 mm) / Defocusing (~100 mm) 100% = 484 μm
Resulting spot size is adjustable from 580 μm (120%) to 460 μm (95%).

Fig. 130: Optical System with adjustable larger spot size



Defocusing (~200 mm) / Focusing (100 mm) 100% = 484 μm
Resulting spot size is adjustable from 474 μm (98%) to 314 μm (65%)

Fig. 131: Optical System with doublet for a adjustable small beam size of 314 μm

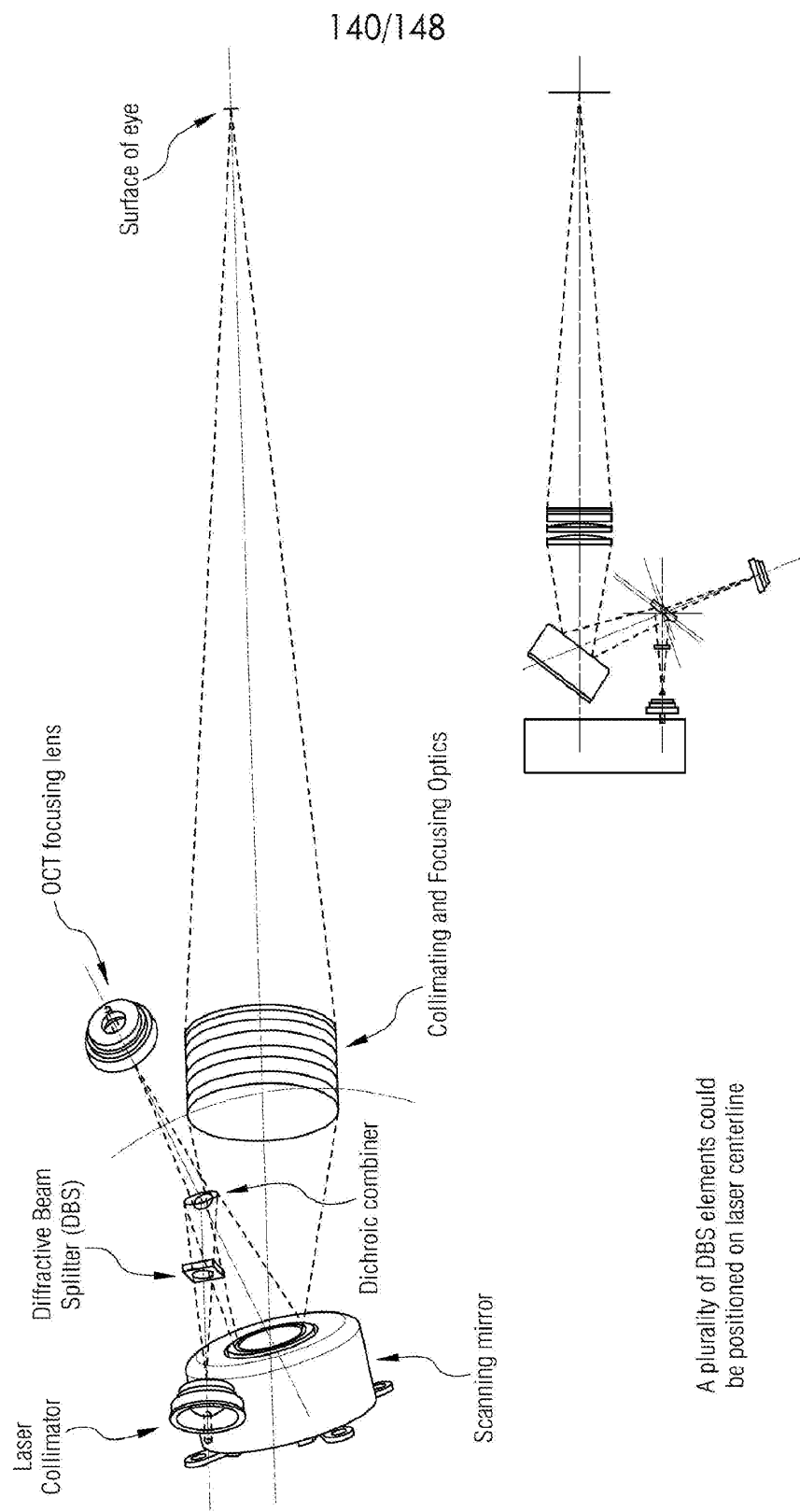


Fig. 132: Optical Design for Integrated OCT scanner

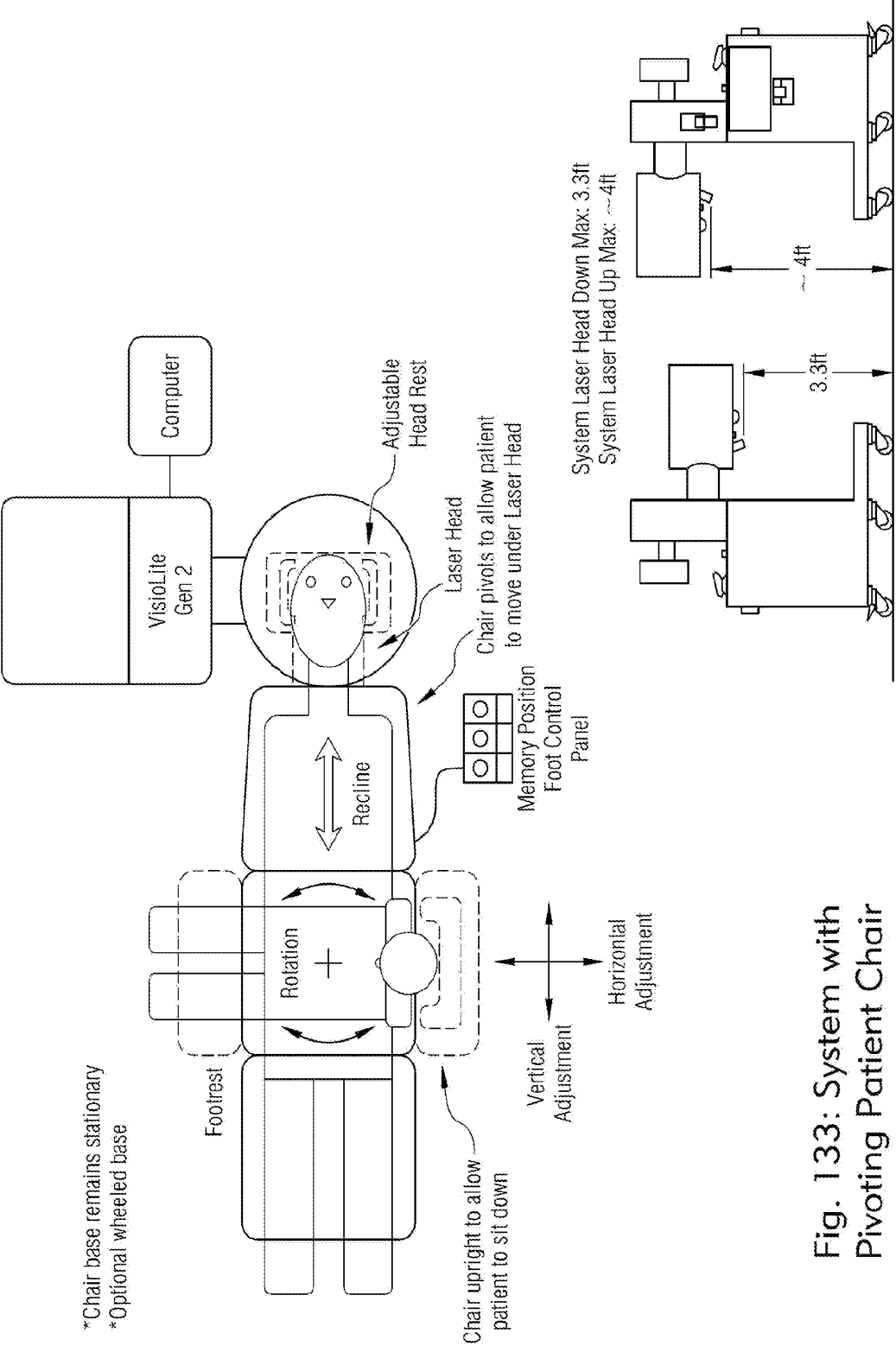
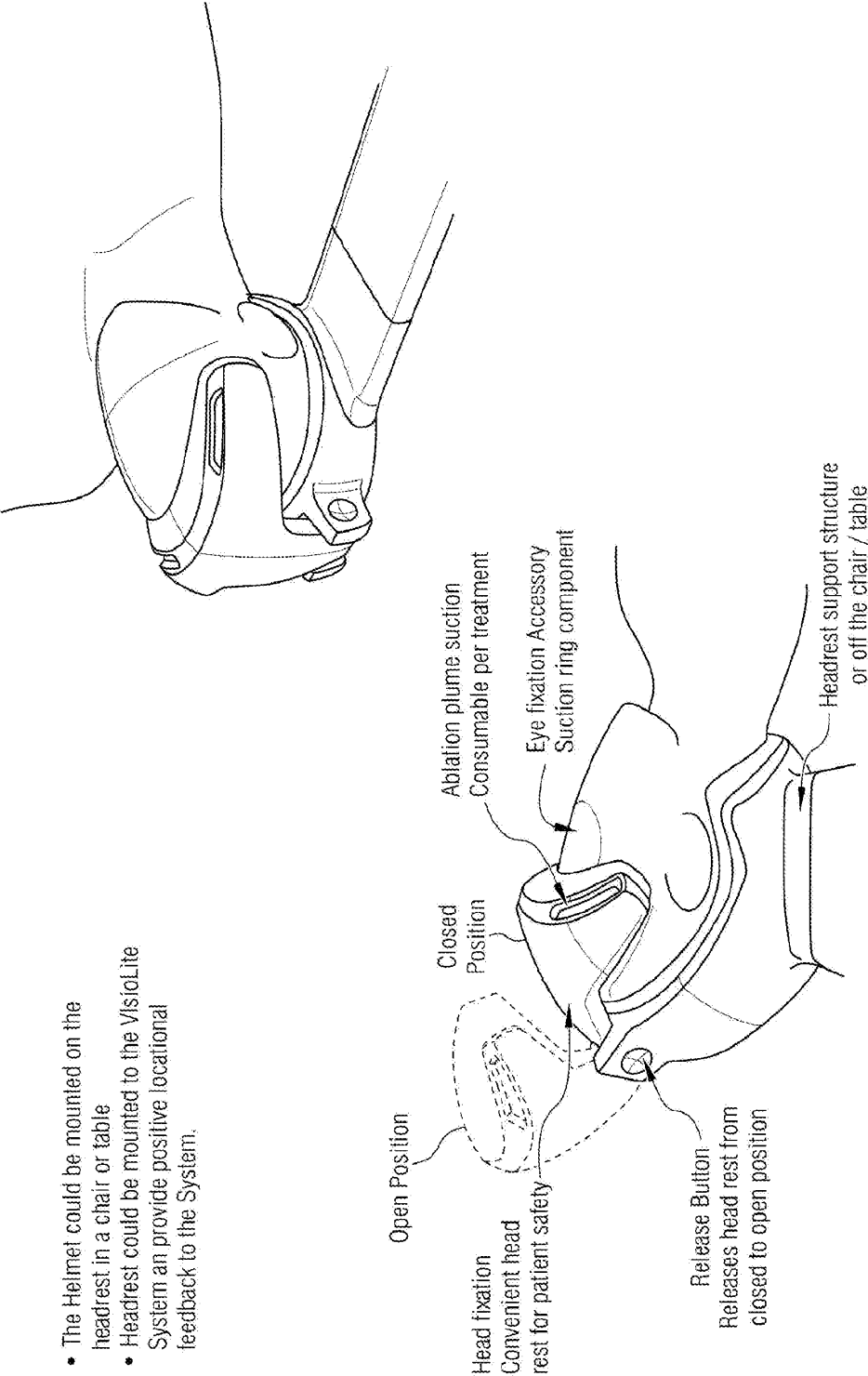


Fig. 133: System with Pivoting Patient Chair

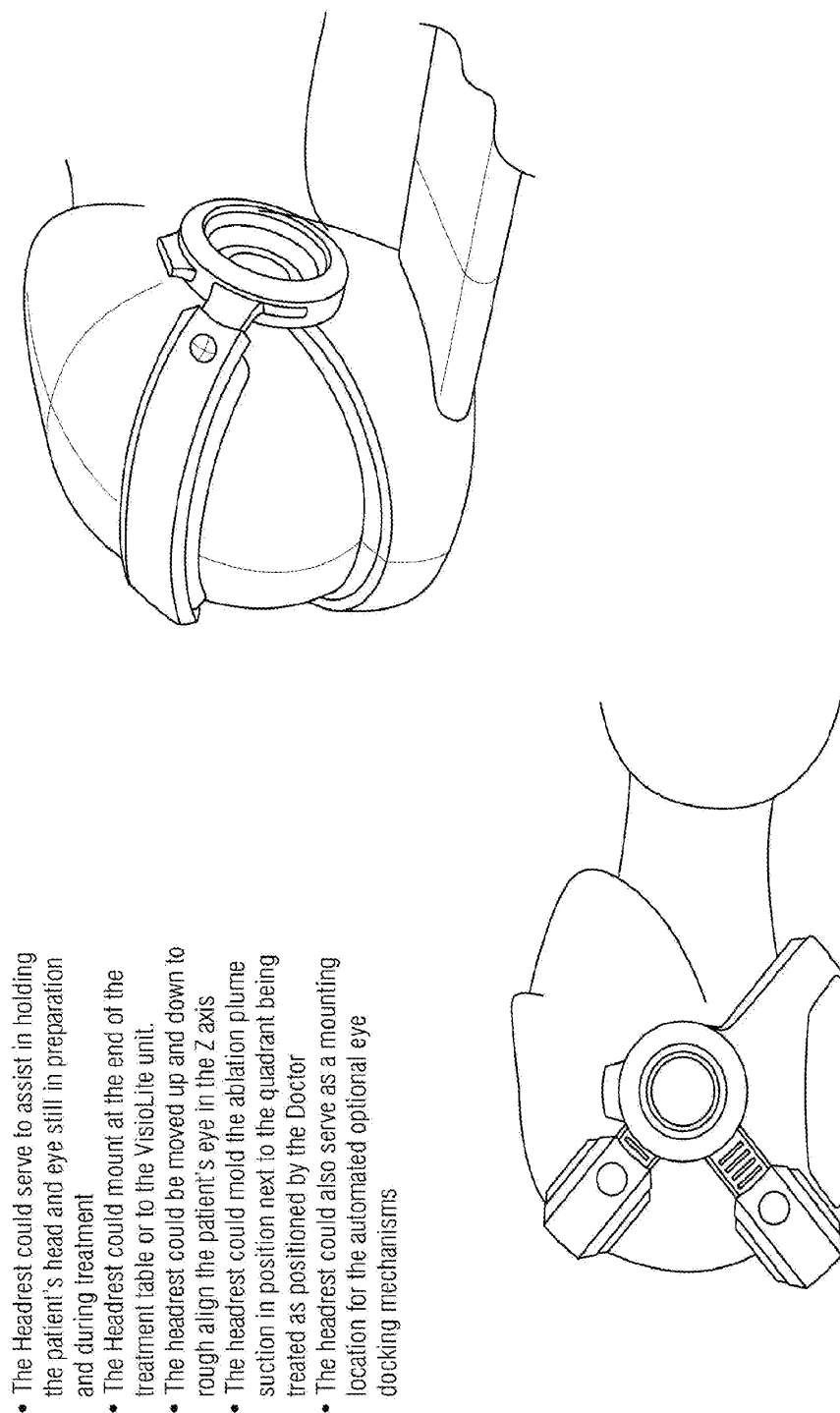
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- The Helmet could be mounted on the headrest in a chair or table
- Headrest could be mounted to the VisioLite System and provide positive locational feedback to the System.

FIG. 134: The Helmet / Headrest with integrated Plume nozzle

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- The Headrest could serve to assist in holding the patient's head and eye still in preparation and during treatment
- The Headrest could mount at the end of the treatment table or to the VisioLite unit.
- The headrest could be moved up and down to rough align the patient's eye in the Z axis
- The headrest could mold the ablation plume suction in position next to the quadrant being treated as positioned by the Doctor
- The headrest could also serve as a mounting location for the automated optional eye docking mechanisms

FIG. 135: Concepts for Headrest and Helmet

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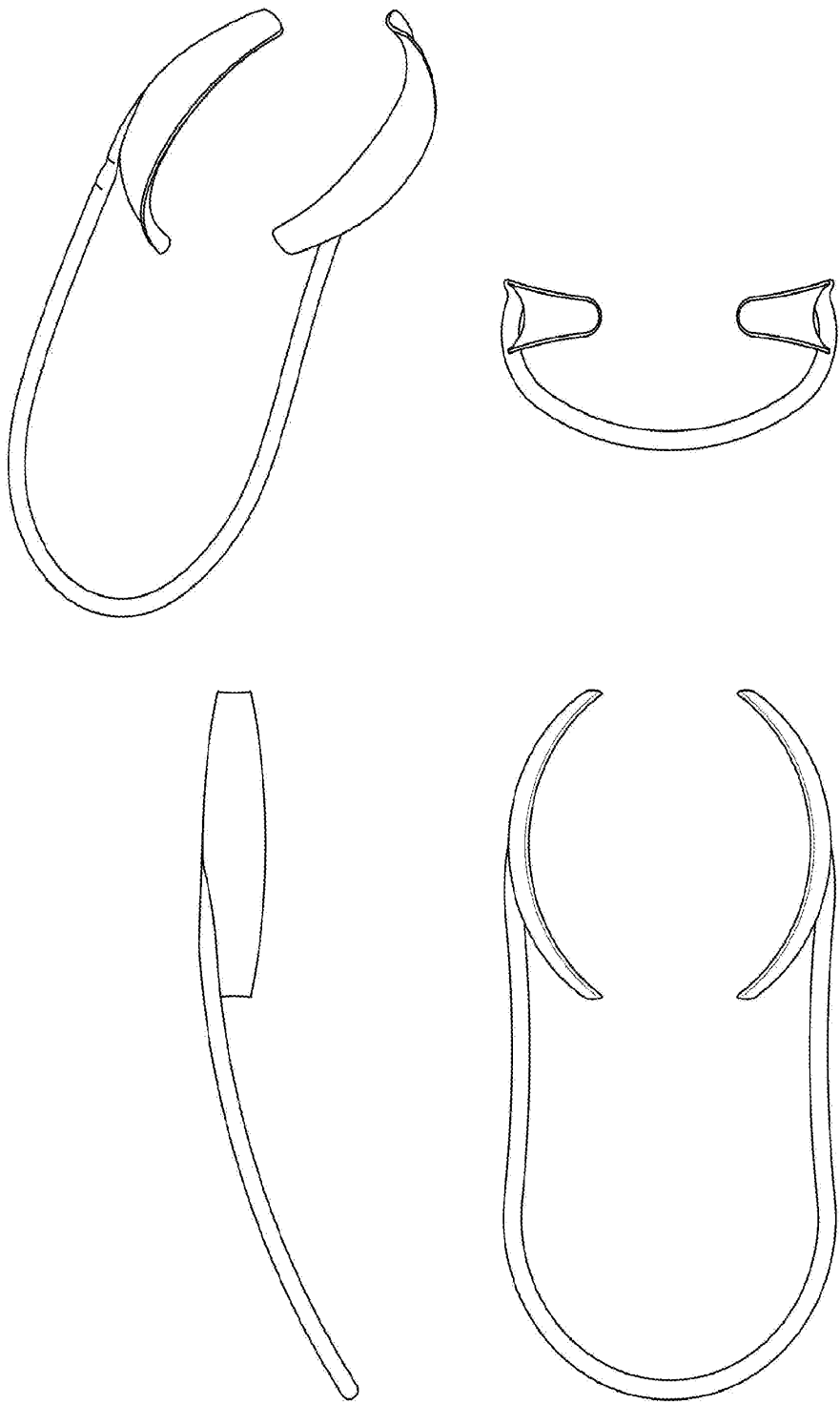


Fig. 136: Speculum

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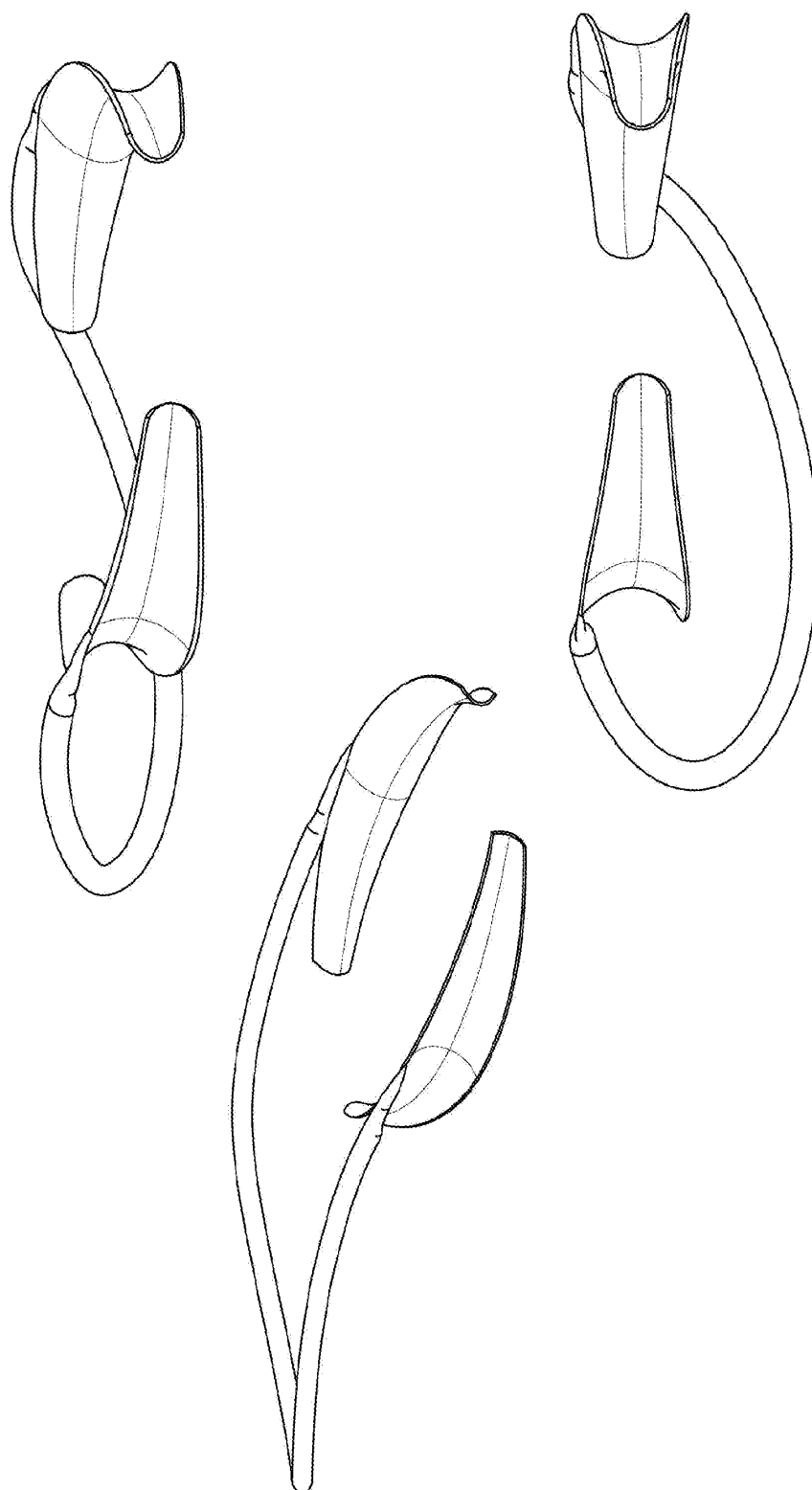


Fig. 137: Disposable Speculum with Silicone Overlay

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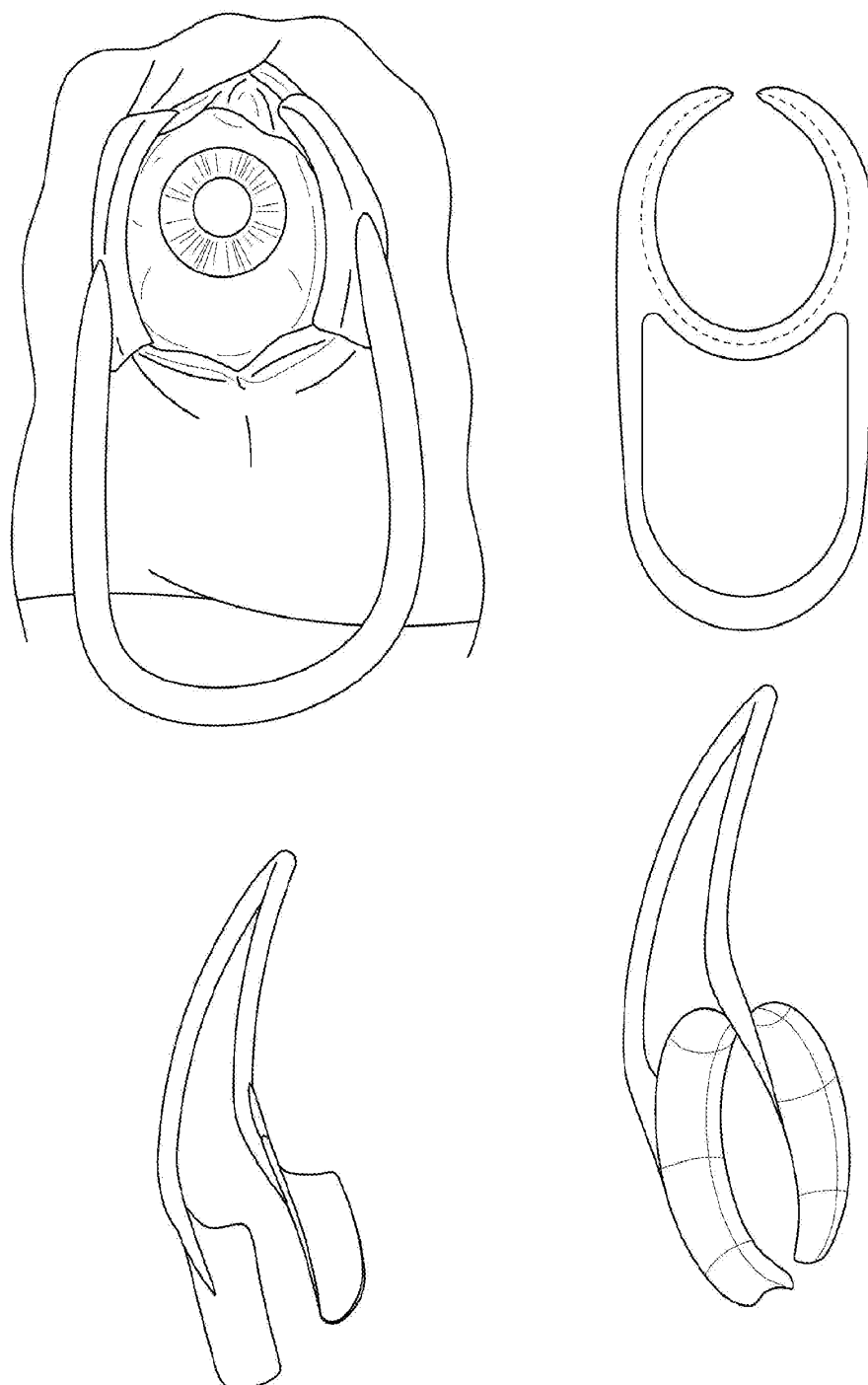


Fig. 138: Speculum

Table 2 Thickness (μm) of Anterior Corneal Layers After Laser Ablation				
Layer Type	Free Running Er:YAG Laser	Q-switched Er:YAG Laser	Optical Parametric Oscillator Laser	Excimer laser (VISX Star)
Surface debris	0 to 0.2	0 to 1.0	0 to 0.4	0 to 0.3
Sub-ablation damage zone	3 to 6	0.5 to 2	0.1 to 0.2	0.1 to 0.2
Underlying zone	5 to 12 with large vacuoles	2 to 6 with medium vacuoles	0.3 to 2.0 with small vacuoles	0.3 to 2.0 with no vacuoles
Base	Normal stroma and normal endothelium	Normal stroma and normal endothelium	Normal stroma and normal endothelium	Normal stroma and normal endothelium

Fig. 139A: Er:YAG; Q Switched YAG. Average thickness 5-10μm

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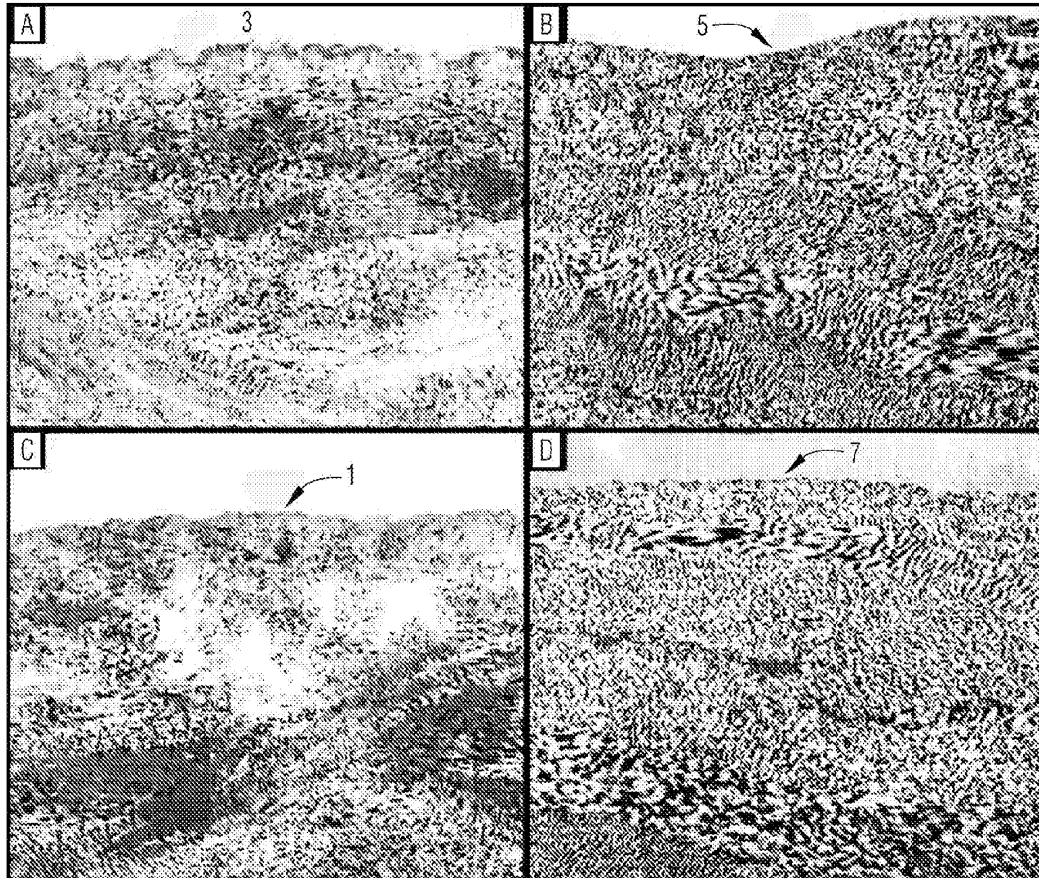


Figure 2. Transmission electron microscopy of PRK ablations on cat eyes at 10,000X corresponding to:
 A) Q-switched Er:YAG laser shows slightly rough surface (3) with dark and white damage areas (4) within 1 to 2 μm of the surface. B) Optical parametric oscillator laser. Note the smooth surface (5) with small damage zone (6) within only one-third micron of the surface. C) Long-pulse Er:YAG laser. Note the thick damage zone (1) and prominent white coagulated areas (2) which are 5 to 10 μm below the surface. D) Excimer laser. Note the smooth surface (7). Damage zones of less than one-third micron of the surface, similar to C).

Fig. 139B: Er:YAG; Q Switched
 YAG. Average thickness 5-10 μm

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