

FIG. 1A-1

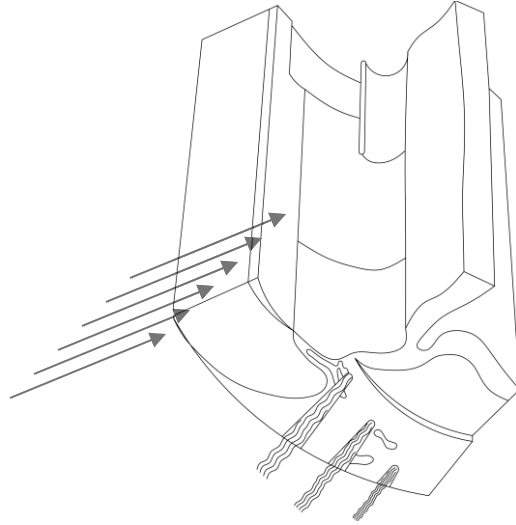
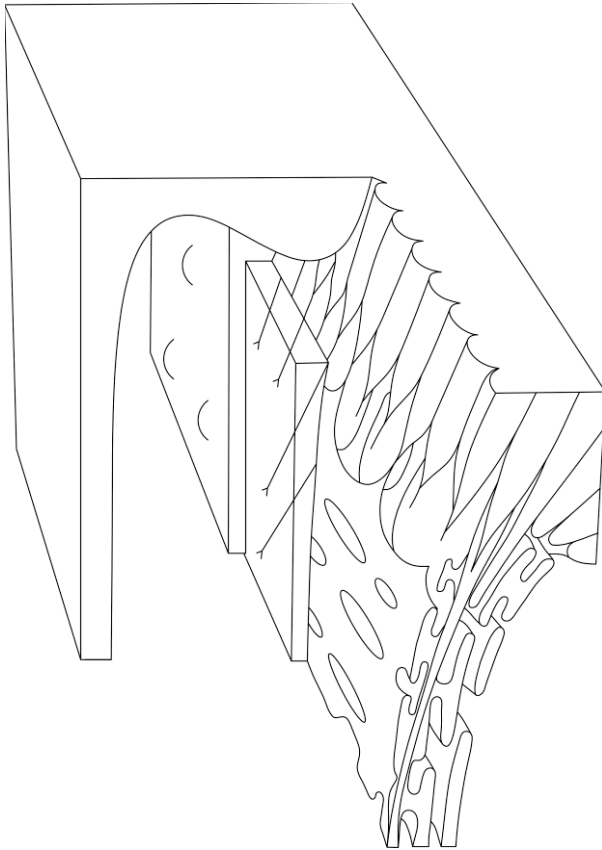
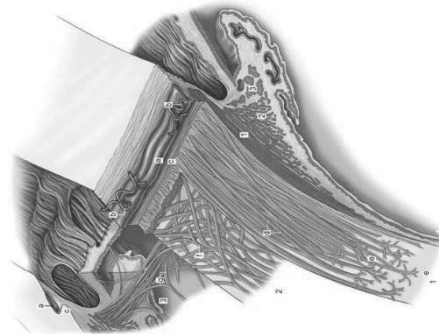


FIG. 1A-3

FIG. 1A-2



Posterior Scleral Rejuvenation for IOP and Ocular Nerve Head Decompression

Plurality of Treatment Zones in posterior globe

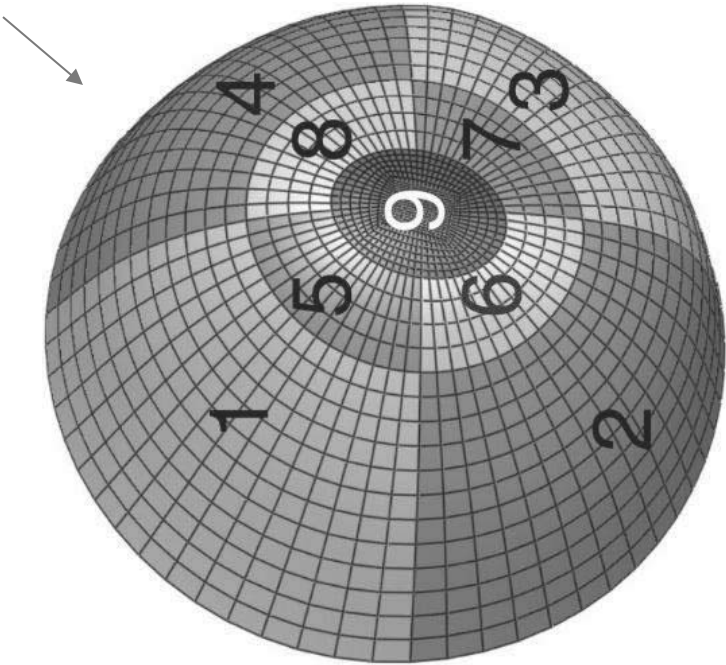


FIG. 1A-4



FIG. 1A-5

Laser Scleral Rejuvenation improves Scleral Compliance and removes stress on physiological tissues around and internal to sclera internal to sclera

Effects of Scleral Biomechanics on the ONH

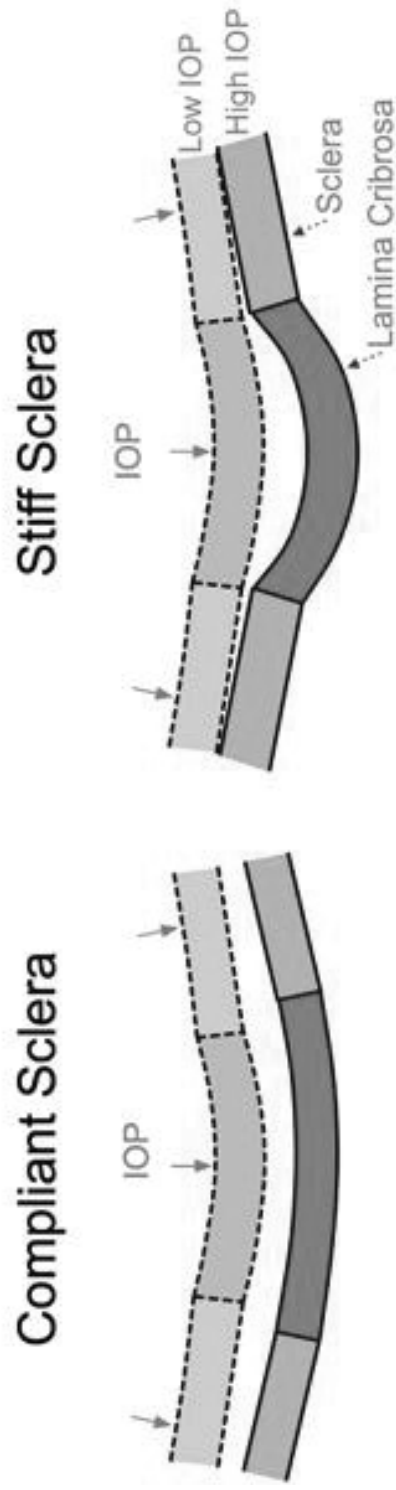


FIG. 1A-6

Mechanism of Action Scleral Rejuvenation to decrease IOP and improve efficient hydrodynamics of physiological functions in the anterior segment

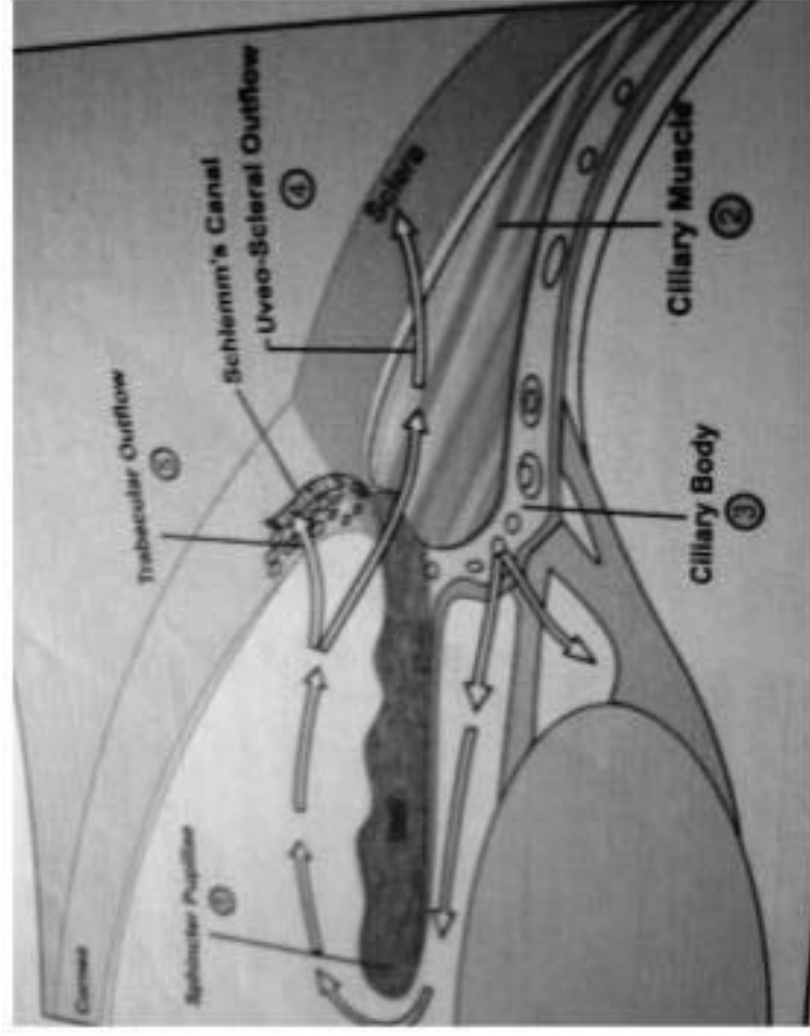


FIG. 1A-7

In Closed Angle: Scleral Rejuvenation improves compliance and allows pulling of the iris opening of the angle

In open Angle: increased contraction of the longitudinal Ciliary muscle improves drainage of aqueous.

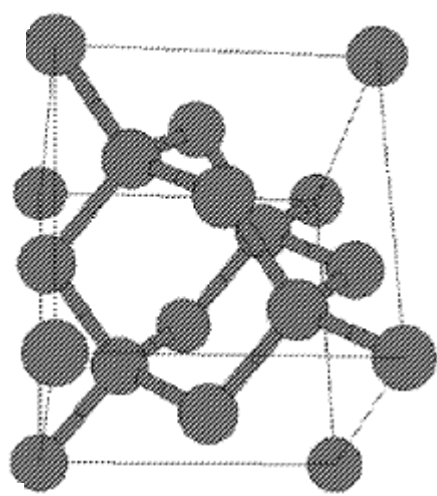


FIG. 1C

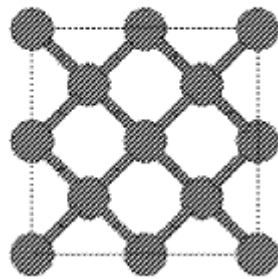


FIG. 1E

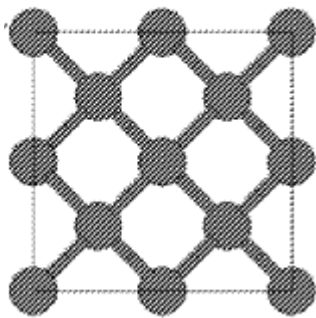


FIG. 1B

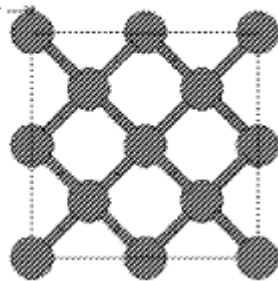


FIG. 1D

Coagulation Zones based on Pulse width

In order to find out these coagulation zones we use in 25W laser with the pulse lengths 100, (125), 150 and 200 microsec at 100Hz and then roughly the same fluence for all spots 250,325 and 425 microns. Then we extrapolate the curve down to 50 microsec that might give us info on the approx. coagulation zone

- @ 20 J/cm² for 250 um: 90 us
- @ 20 J/cm² for 325 um: 125 us
- @ 20 J/cm² for 425 um: 160 us

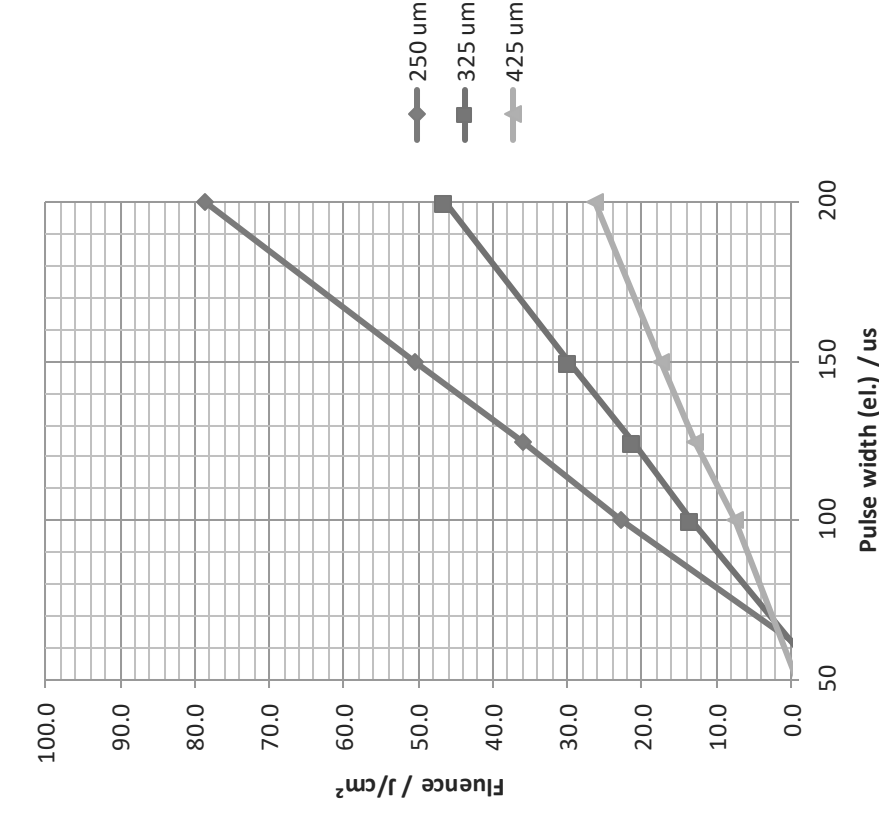
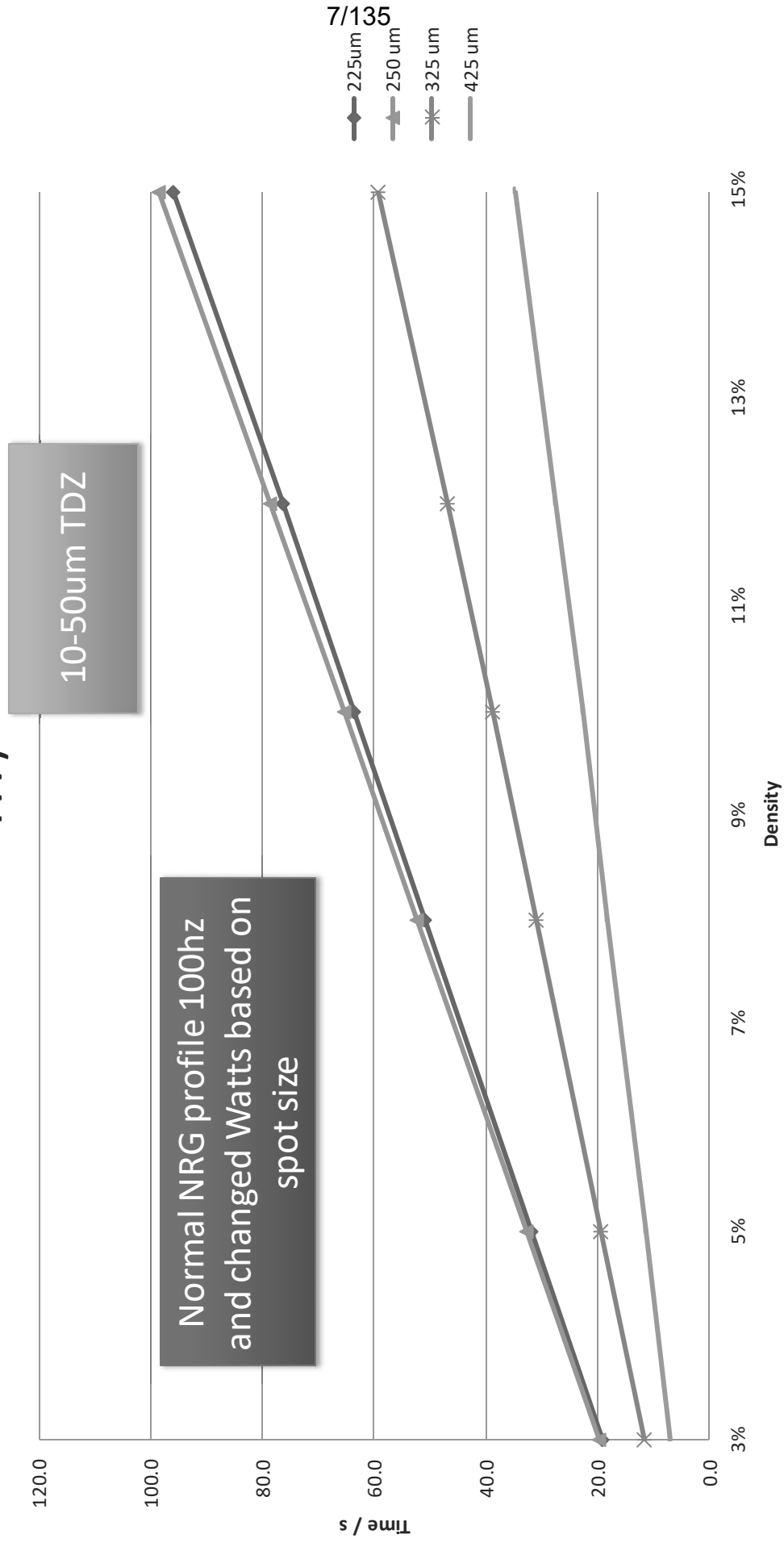


FIG. 1E-1

FIG. 1E-2

Pattern Speed Calculation based on Fibonacci Spiral (full eye) with 80 % (12 PPP)



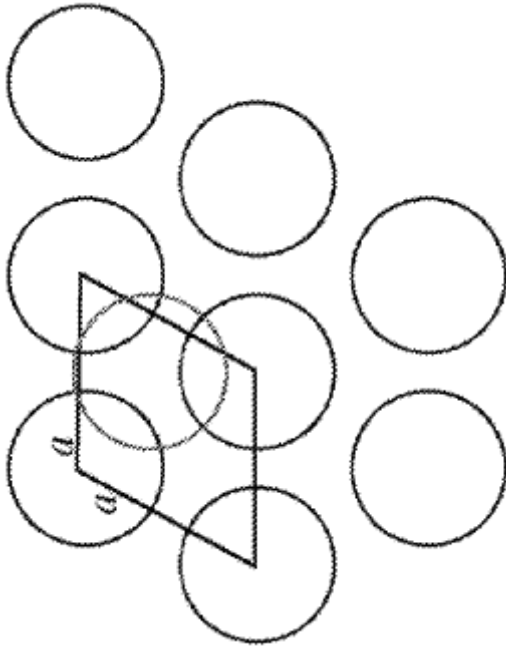


FIG. 1F(a)

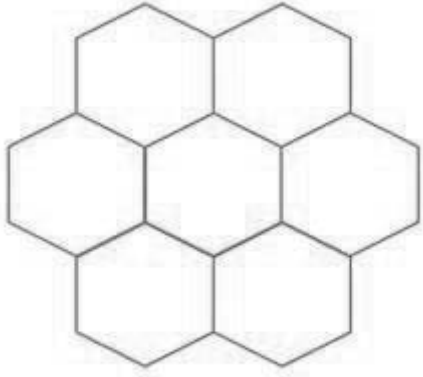


FIG. 1F(b)

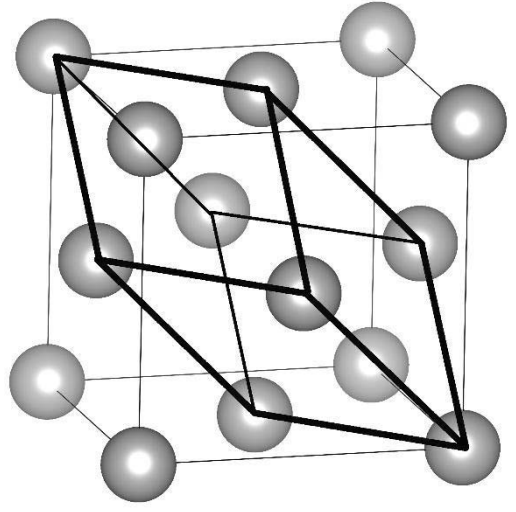


FIG. 1F(c)

Laser Profile optimized for lower Thermal Damage Zone to surrounding tissues is low

eye	position	density / %	number of pulses	Setup according to WP3	
1	a/b/c/d	5/7/10/13	5	S 1	
2			40		
3			10	S 3	
4			10	S 3 + pressure on pupil	
5			50	S 4	
6			10	S 3	
7			30	S 6	
8			30	S 6	
9			50	S 4	
10		10/13/5/7	10/10/30/30	S3/S3/S6/S6	
11		10/13/5/7	10/10/30/30	S3/S3/S6/S6	

FIG. 1G-1

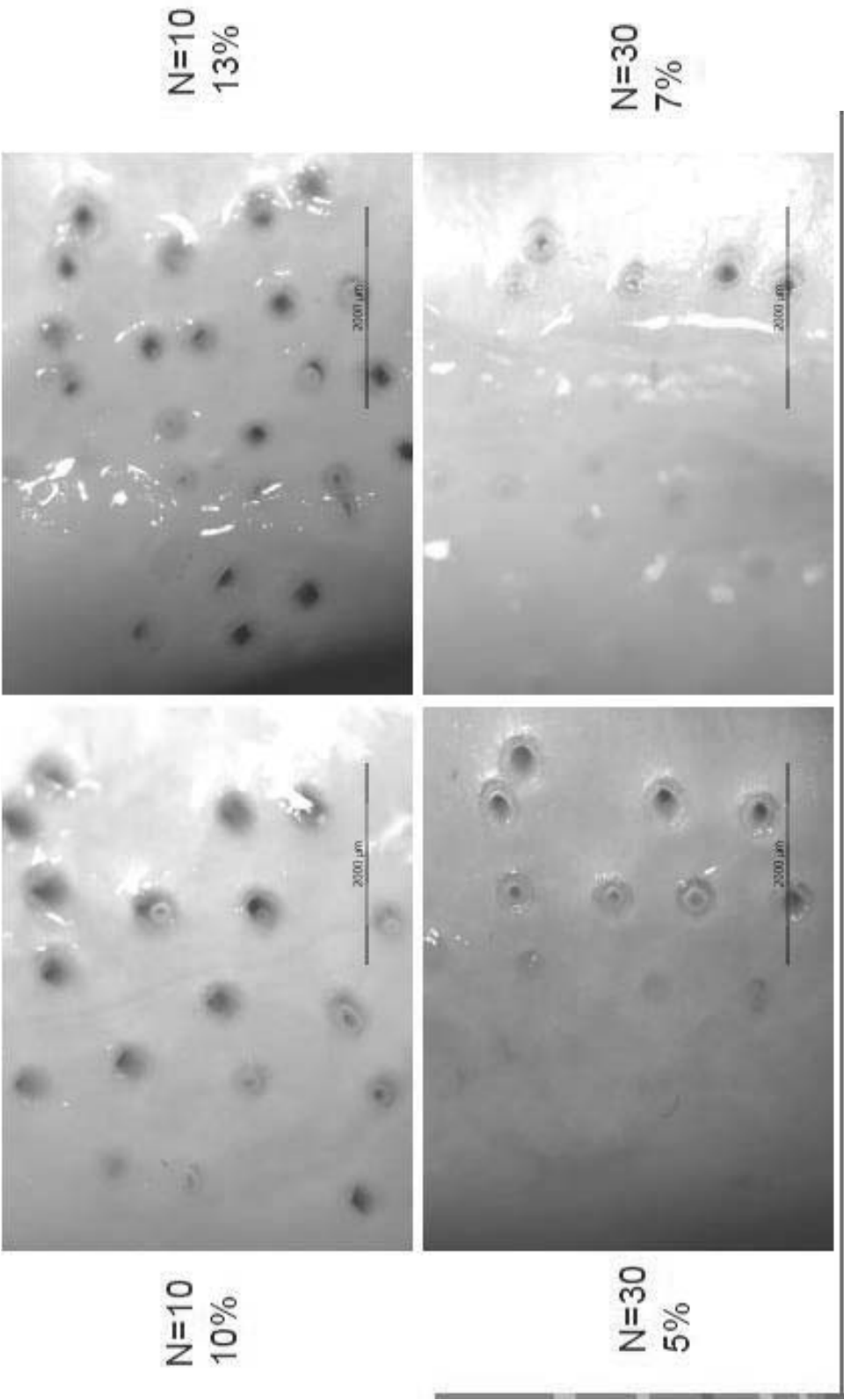


FIG. 1G-2

Laser Profile optimized to have lower Thermal Damage Zone to surrounding tissues
within 50um-80um

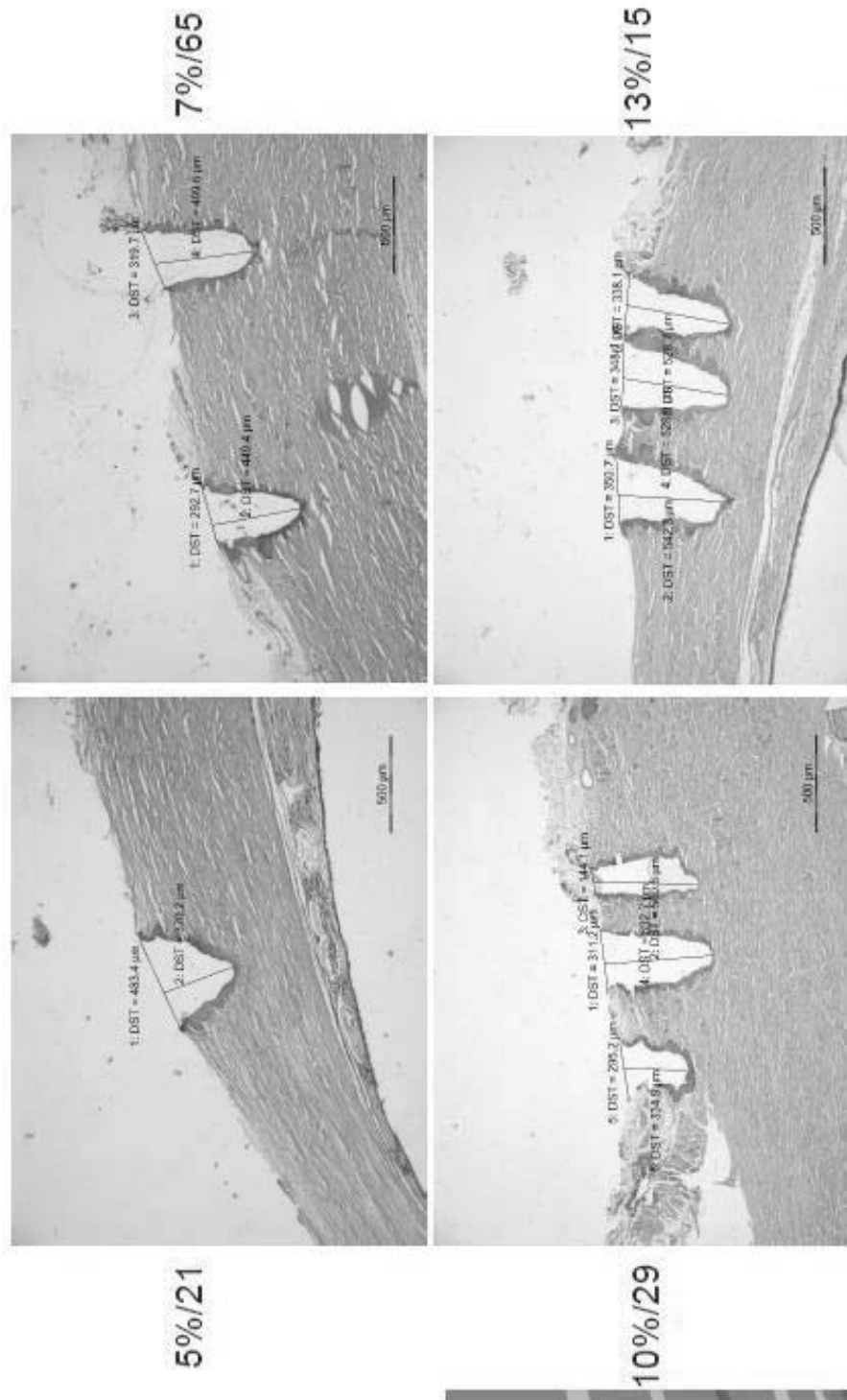
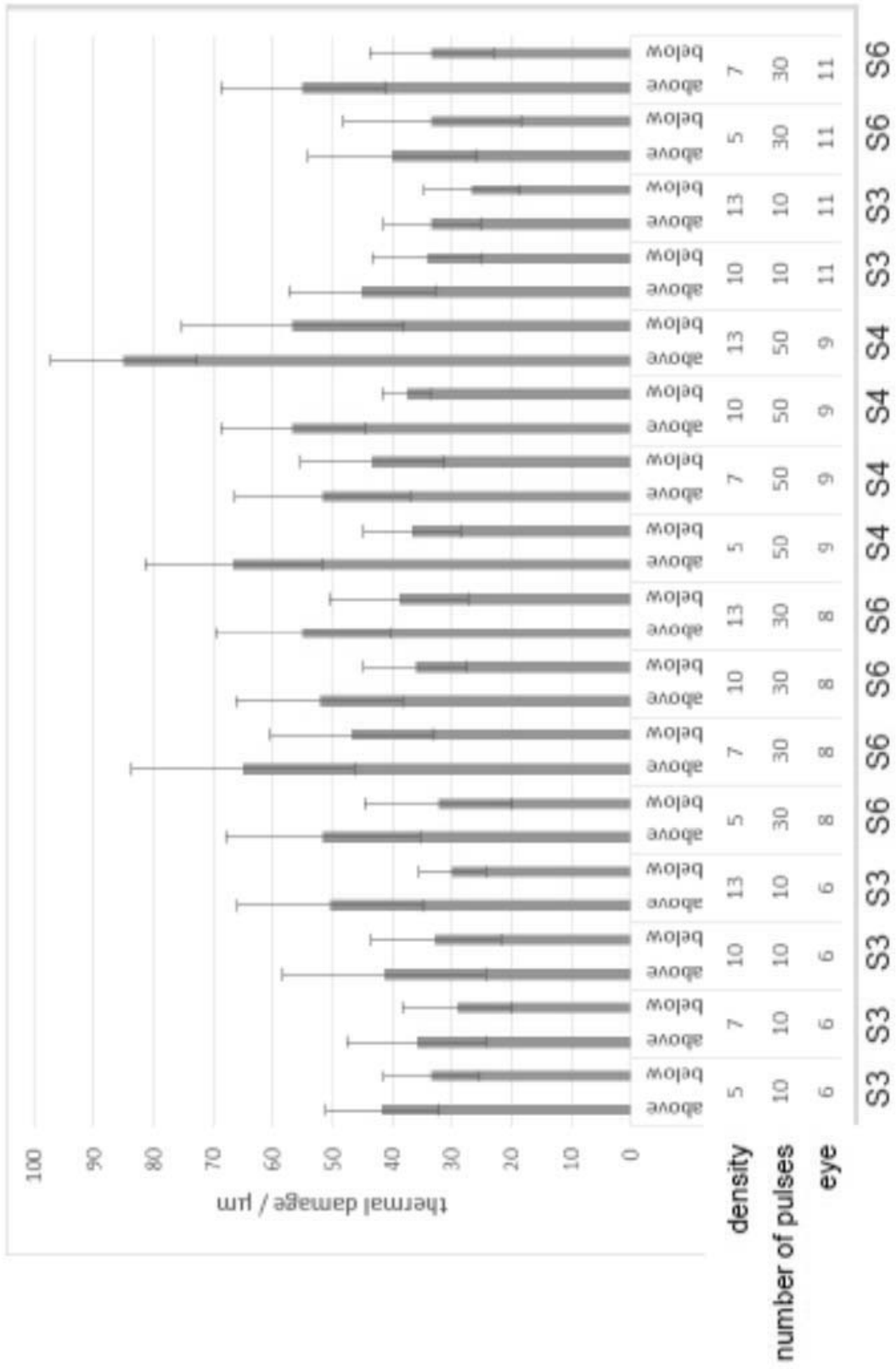


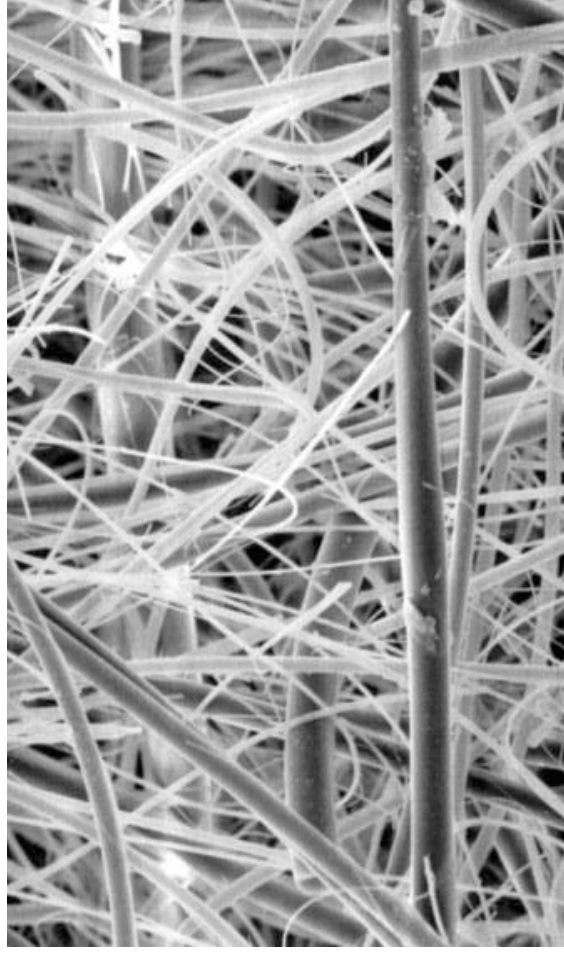
FIG. 1G-3



Important Pore Structure Characteristics

Pore throat diameter
(Specific dimension properties)

Pore Volume
(Tissue Differentials)



Largest diameter
(Barrier properties)

Pore distribution
(Matrix effects-polygon)

FIG. 1H

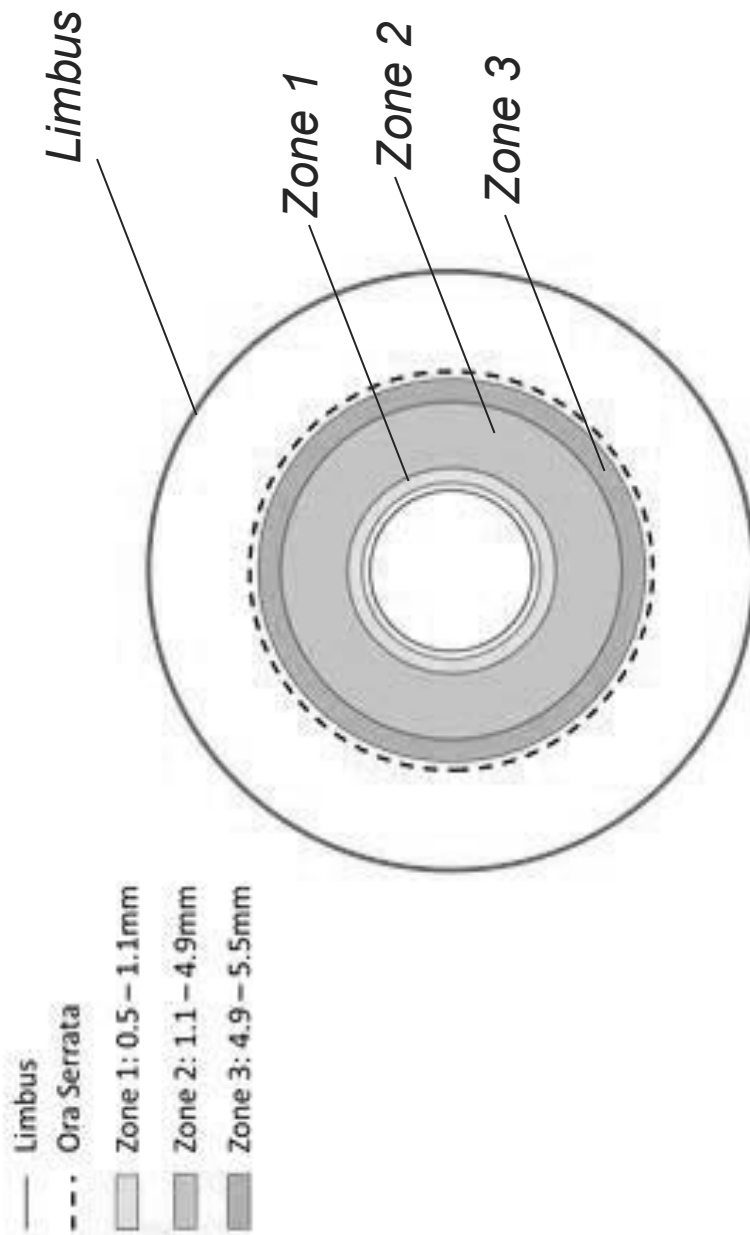


FIG. 2A-1

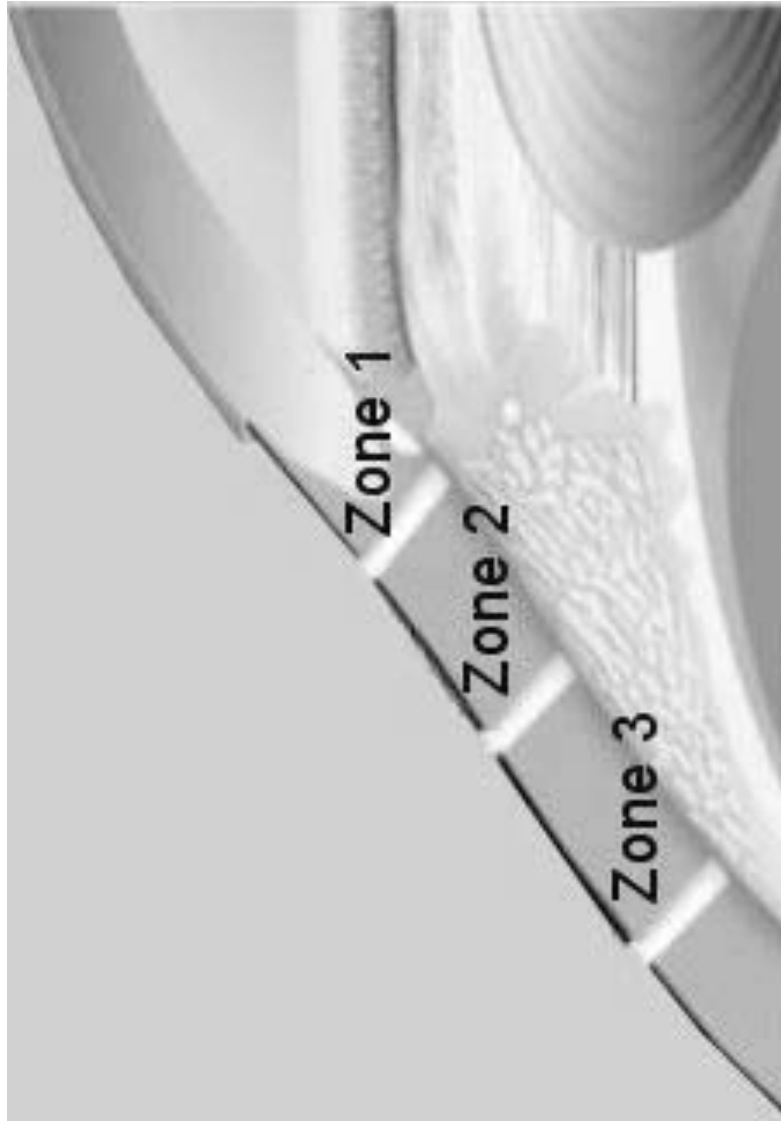


FIG. 2A-2

Final 5 Critical treatment zones (Zones 0-4)

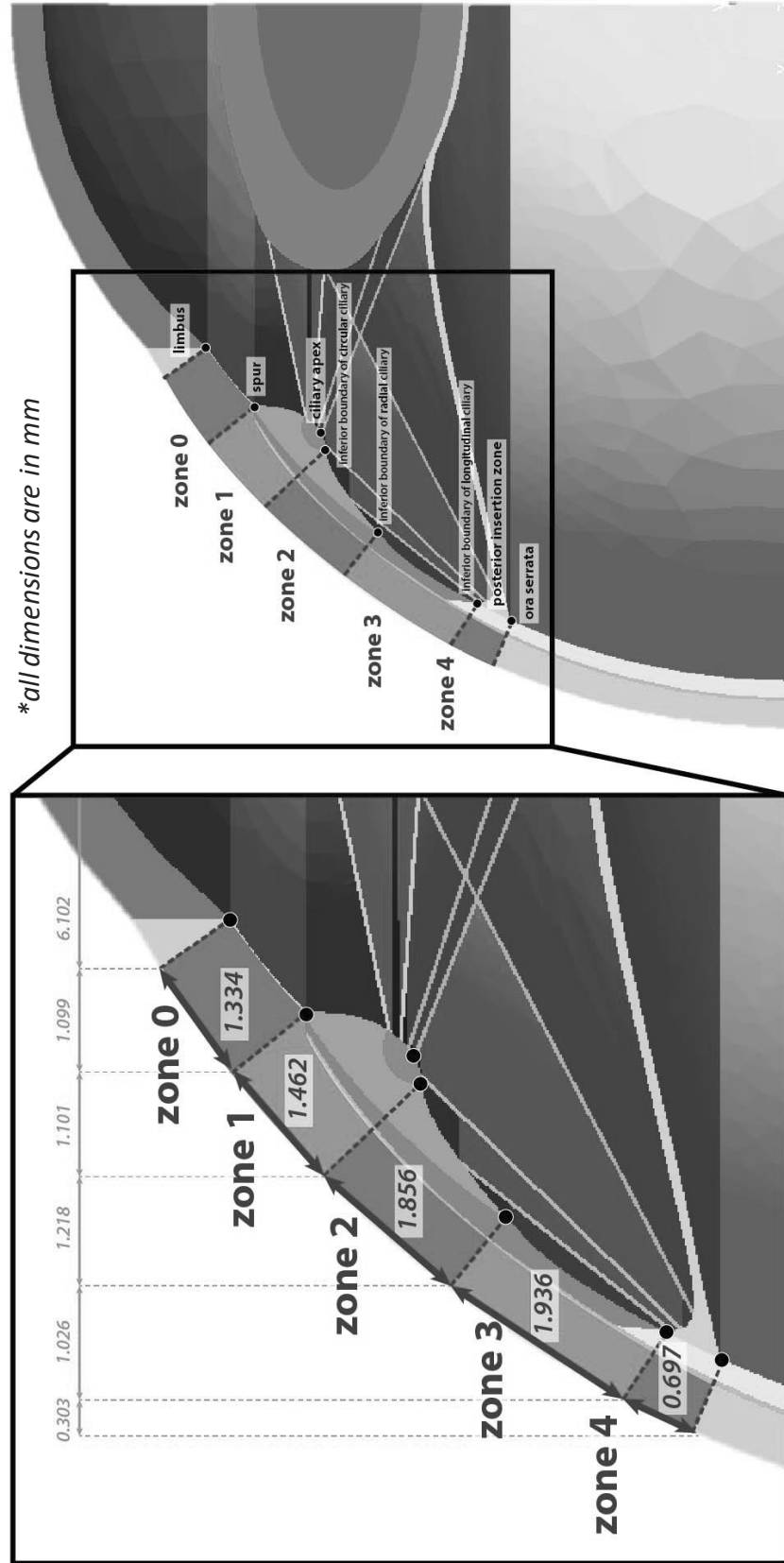


FIG. 2B-1

Zones and treatment areas

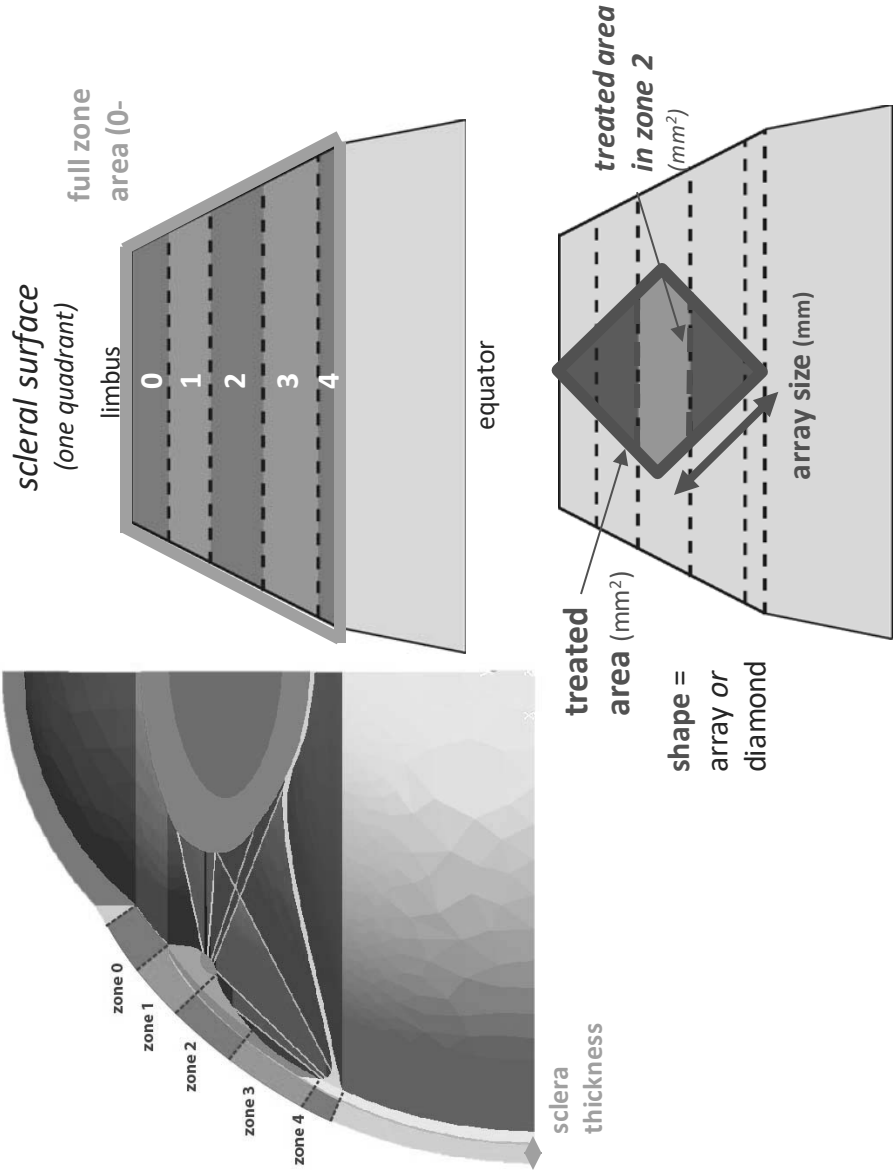


FIG. 2B-2

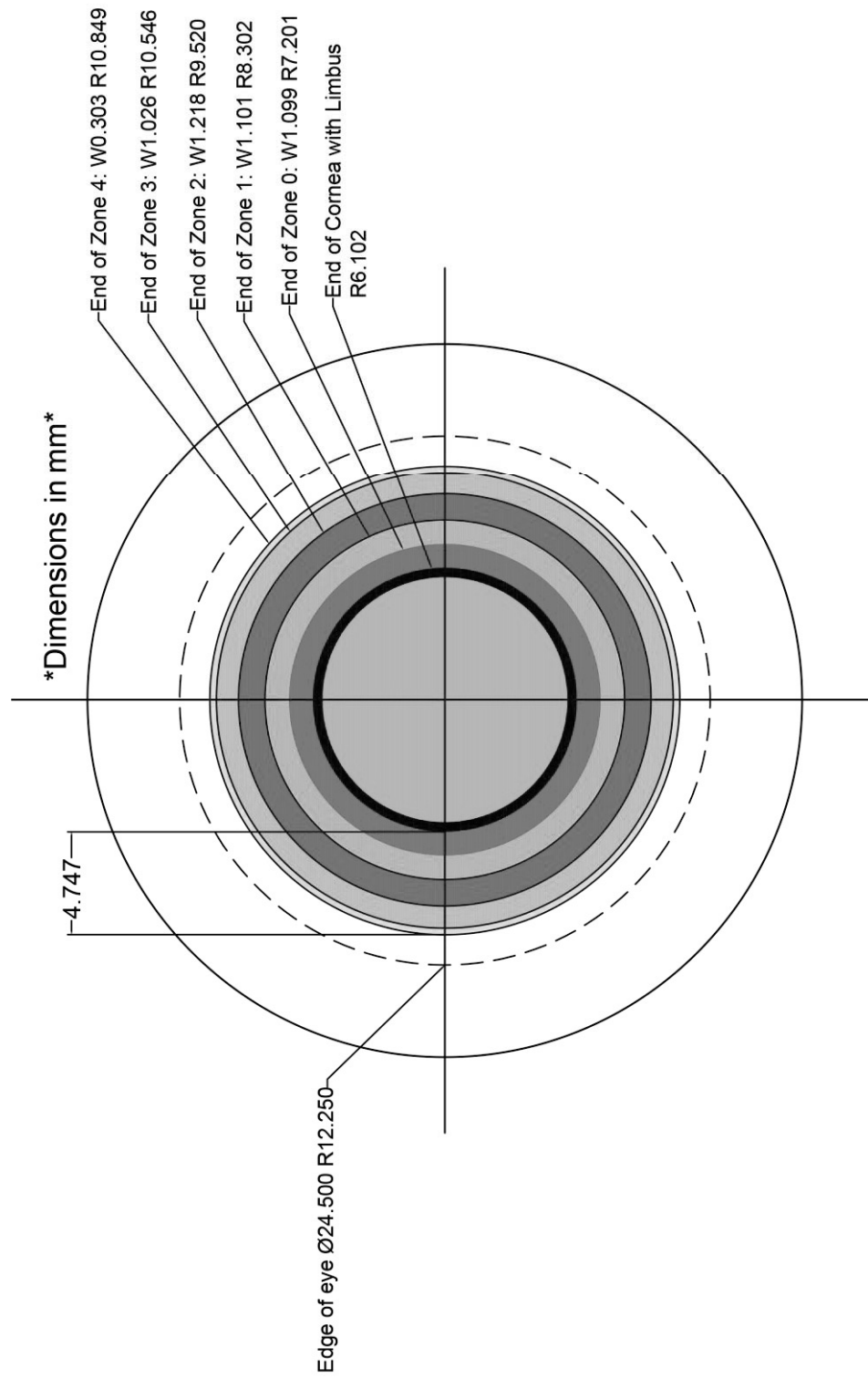
**FIG. 2B-3**

FIG. 2C-3

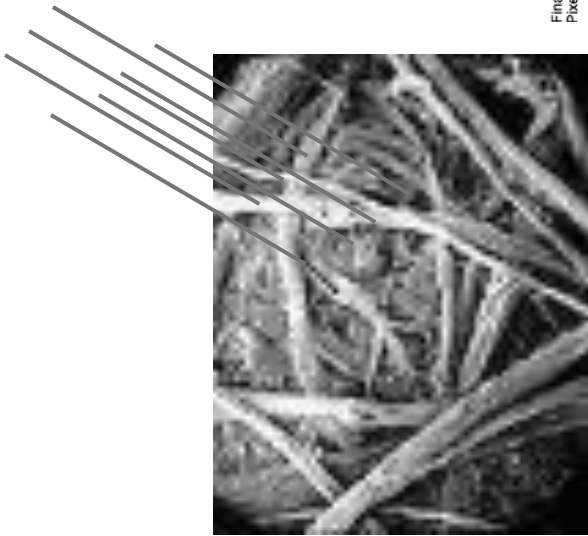
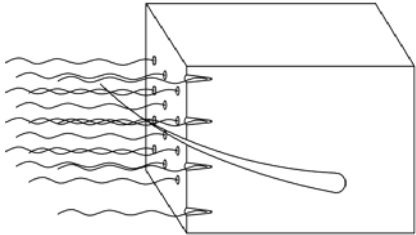


FIG. 2C-1

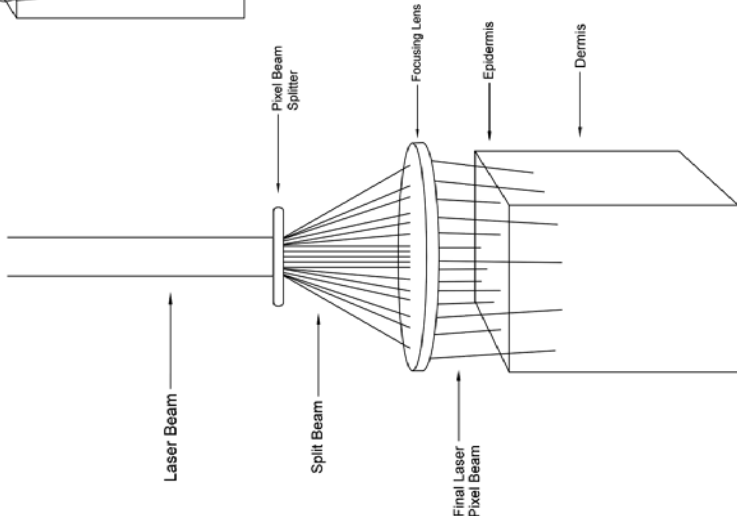


FIG. 2C-2

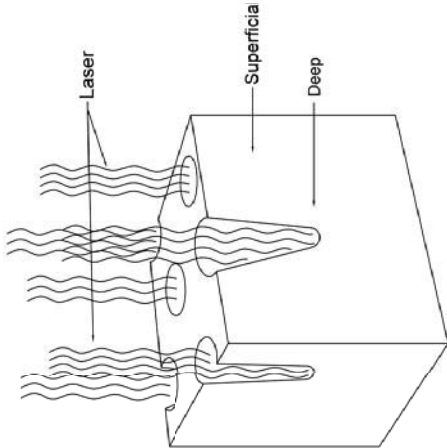


FIG. 2C-4

Laser Scleral Microporation:
Uncrosslinking Breaking Bonds → Decreased Biomechanical Stiffness

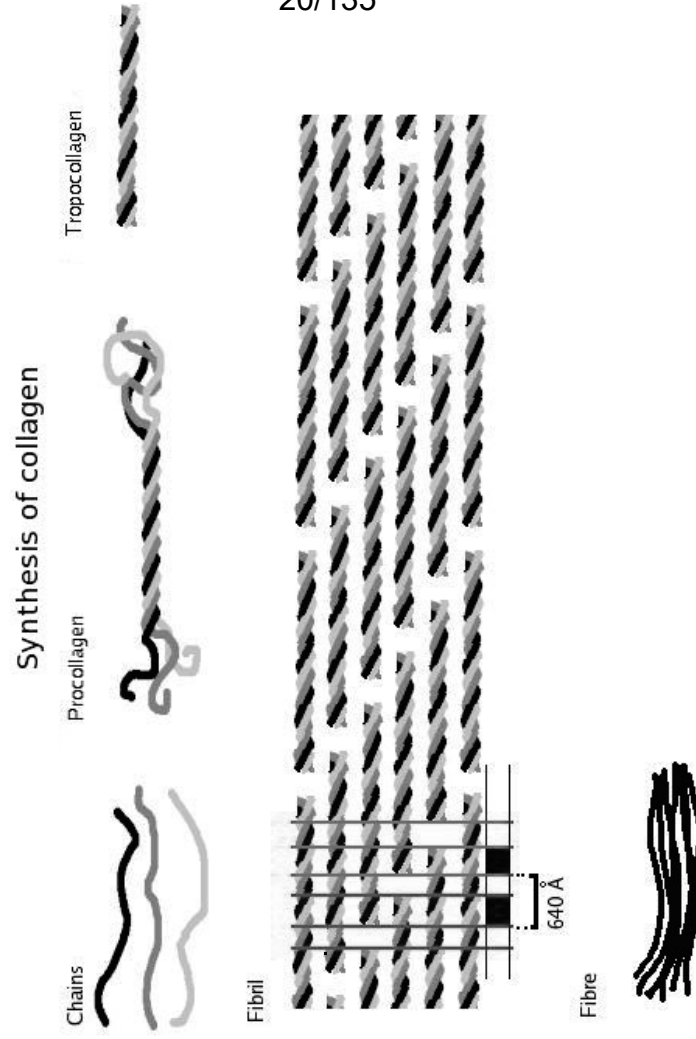
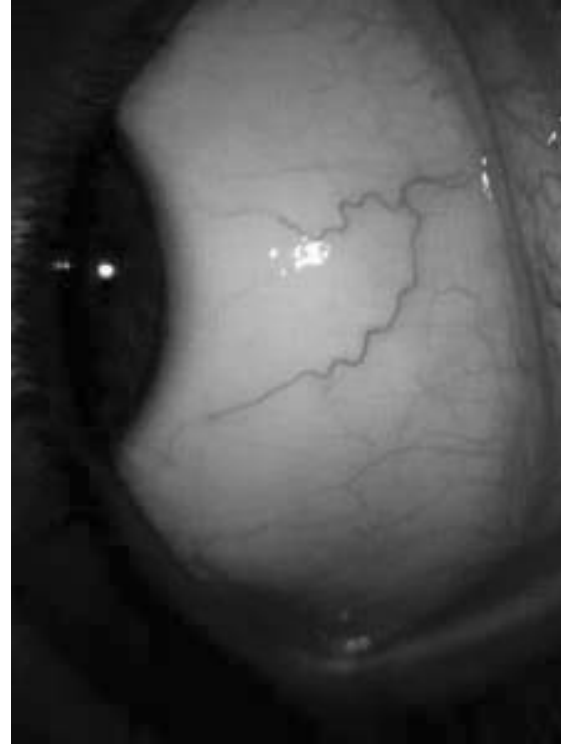


FIG. 2D-1

Change Biomechanical properties improving compliance

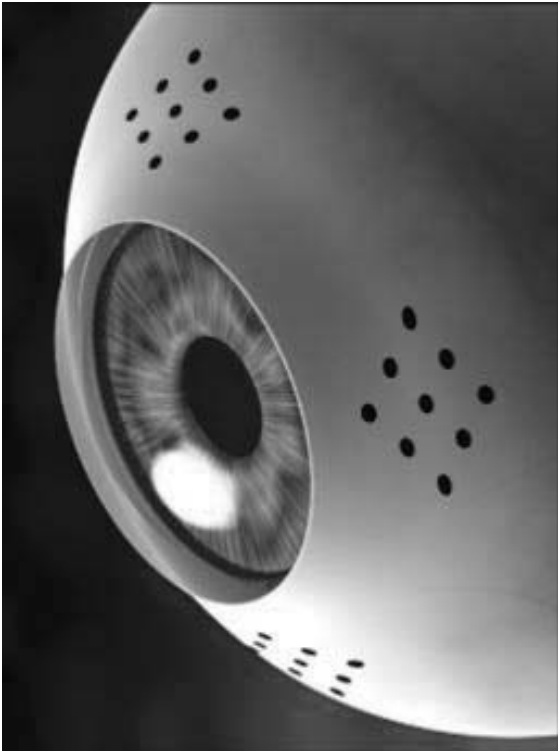


FIG. 2D-2

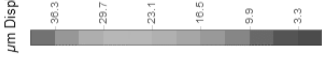
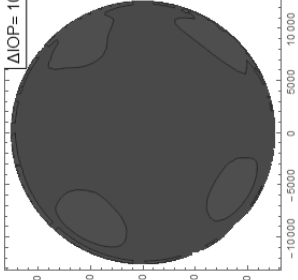
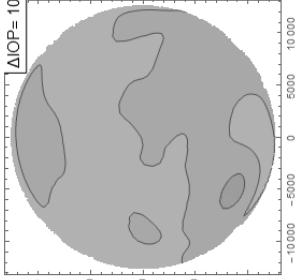
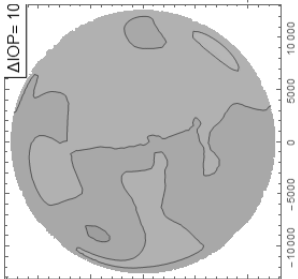
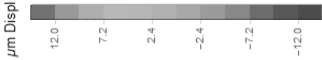
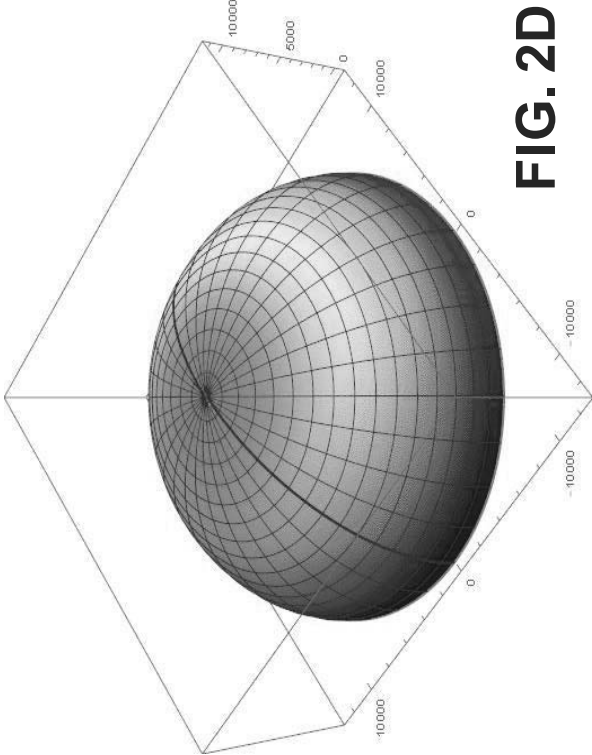


FIG. 2D-4



Shape at 10 mmHg
Disp. magn. x25

FIG. 2D-3

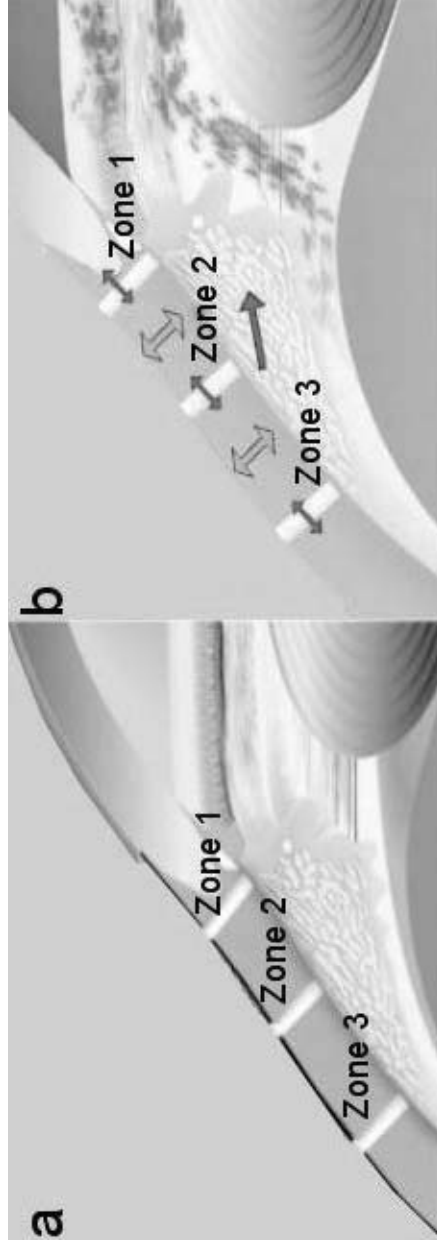


FIG. 2E(a)

FIG. 2E(b)

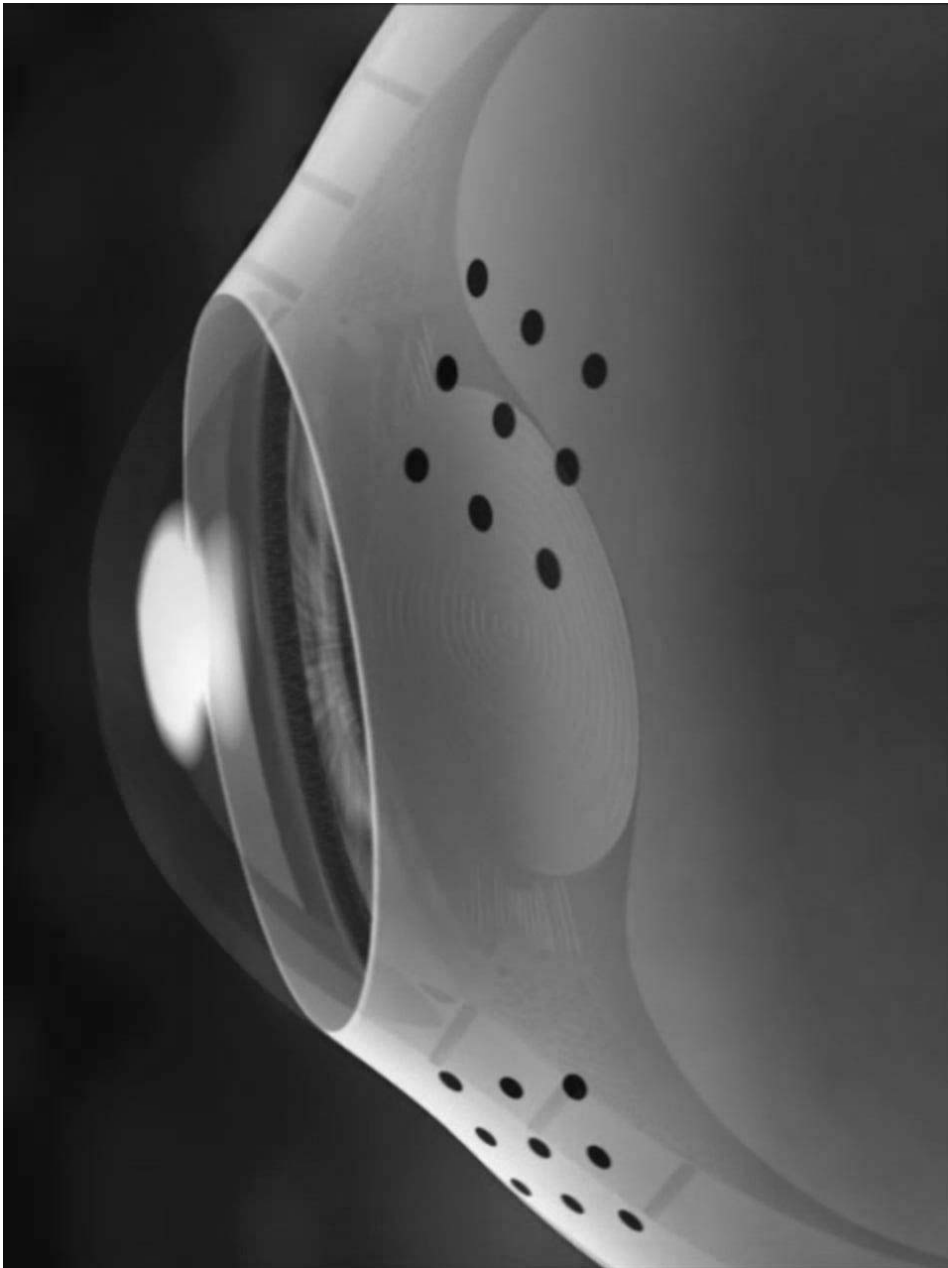


FIG. 2F

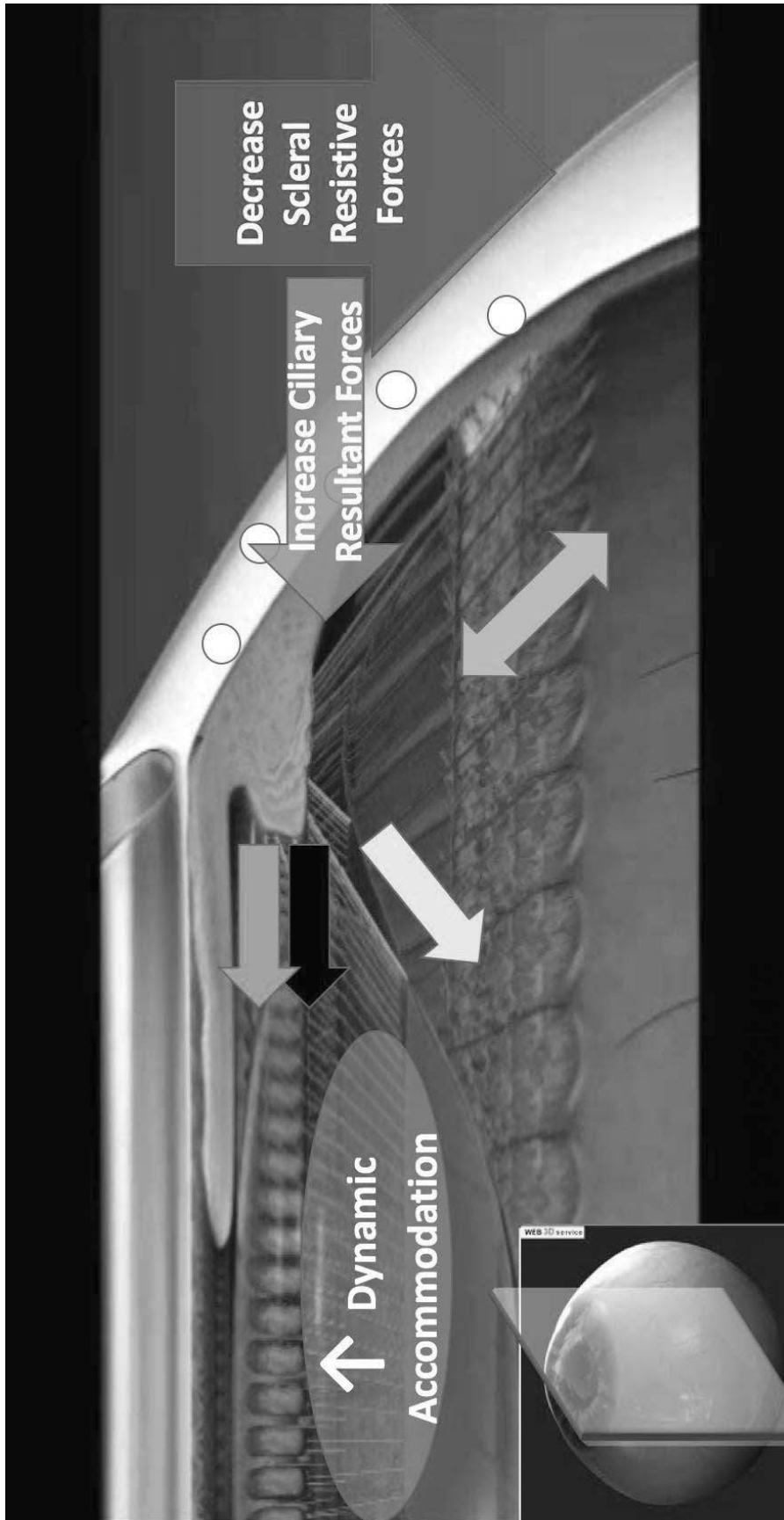


FIG. 2G

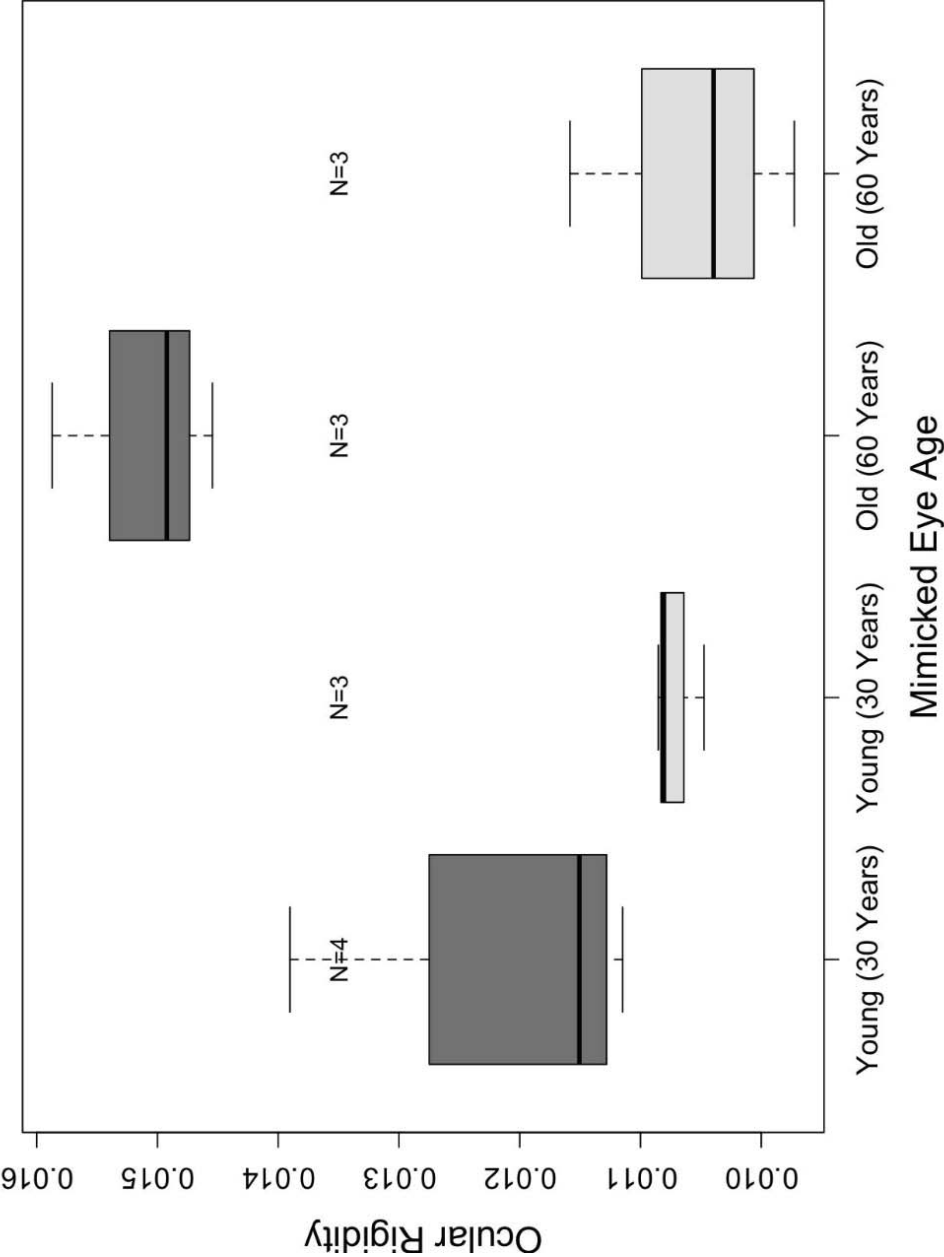


FIG. 2H

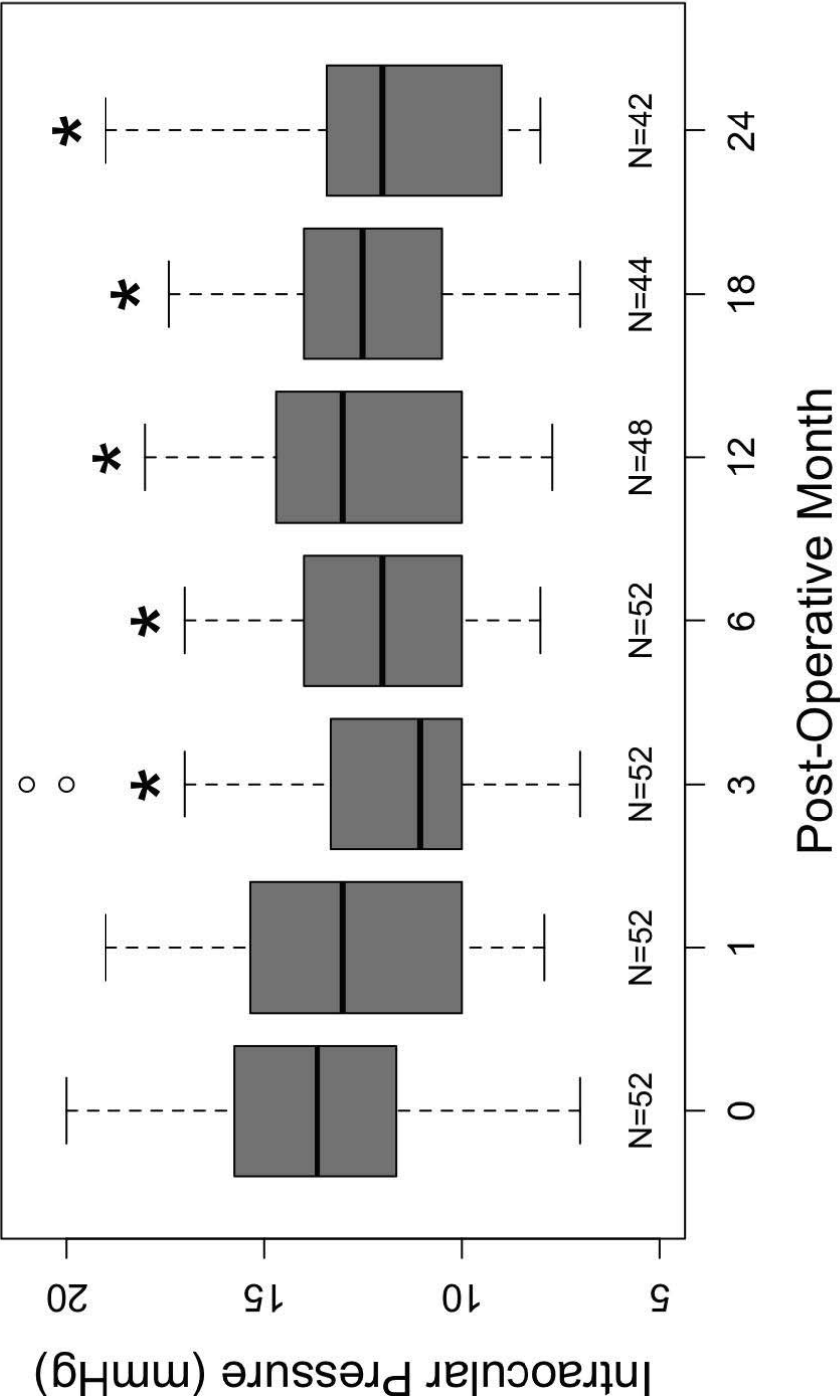
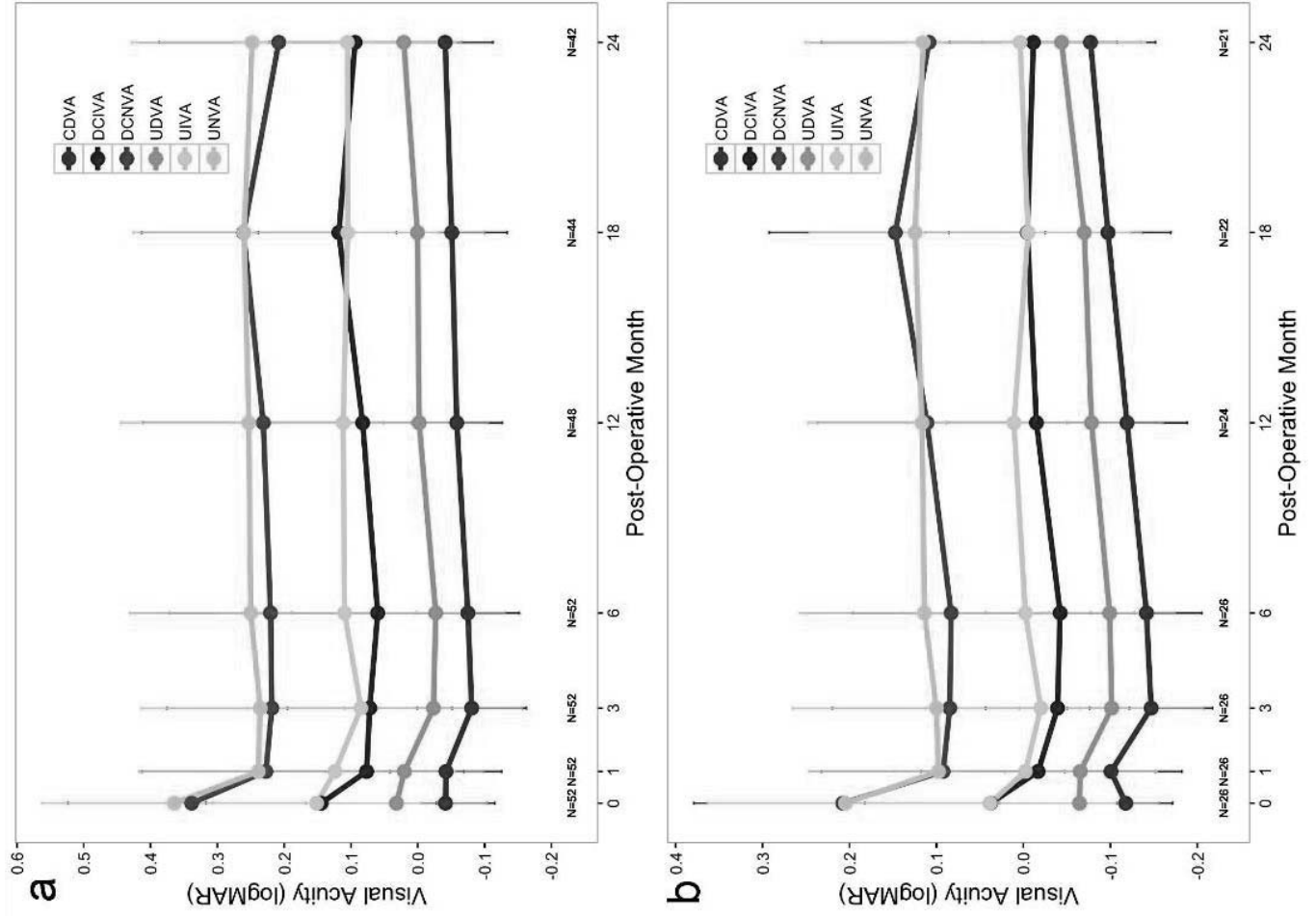


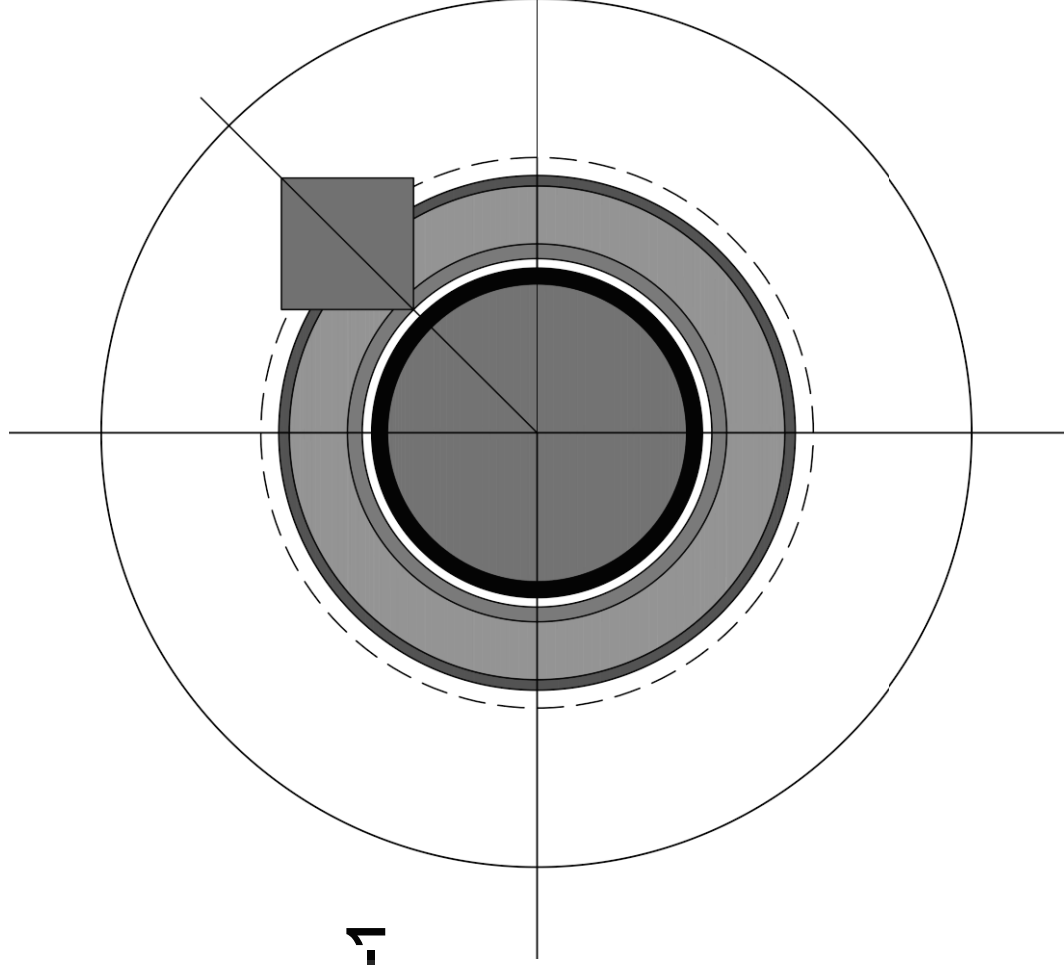
FIG. 2I

FIG. 2J



Protocol 1.1: 225um (169 Total Pores @ 3% = ? Pores/5.5mm Patch: Validated)

FIG. 2K-1



- Total Pores/5.5mm patch
- What we need to know is in EACH protocol how many pores are in the 5x5 patch on the 3D model pursuant to the changing density and the changing spot size.
- We cannot do it in 2D.
- Once we know that , then the patch manipulations can be done.

Protocol: Diamond Pattern All dimensions in mm

Given:					
	0.60	Sclera Thickness			
	0.60	Hole Diameter			
	0.40	Hole Depth			
	1.63	Hole C-C spacing (along square edge)			
	9	Number of Holes (Diamond Pattern)			
	1	# Holes in Zone 1			
	7	# Holes in Zone 2			
	1	# Holes in Zone 3			
Compute:					
	0.28	Hole Surface Area (mm ² , single hole)			
	0.11	Hole Volume (mm ³ , single hole)			
	10.6	% Open Area			

FIG. 2K-1-A

		Sclera								6.Ur
		Area (mm ²)	Volume (mm ³)							
	Zone 1	23.4	5.3							
	Zone 2	189.4	73.1							
	Zone 3	66.5	36.6							
		Sclera		Hole		% Hole				
		Area (mm ²)	Volume (mm ³)	Area (mm ²)	Volume (mm ³)	Area	Volume			
	Zone 1	5.8	1.3	0.28	0.11	4.8%	8.5%			
	Zone 2	47.4	18.3	1.98	0.79	4.2%	4.3%			
	Zone 3	16.6	9.1	0.28	0.11	1.7%	1.2%			
	Total:	69.8	28.8	2.5	1.018	3.6%	3.5%			

FIG. 2K-1-B

Protocol: Diamond Pattern

All dimensions in mm

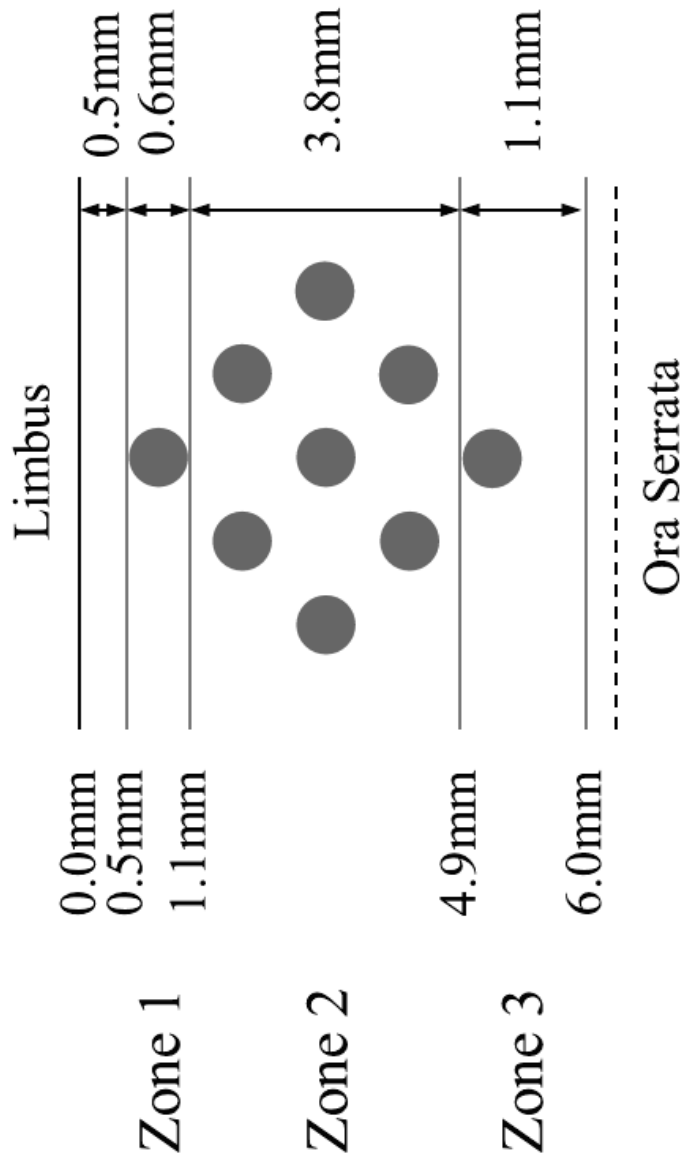


FIG. 2K-1-C

Protocol 1.1: 225um (96 Total Pores @ 3% = 24 Pores/Quadrant: Validated)

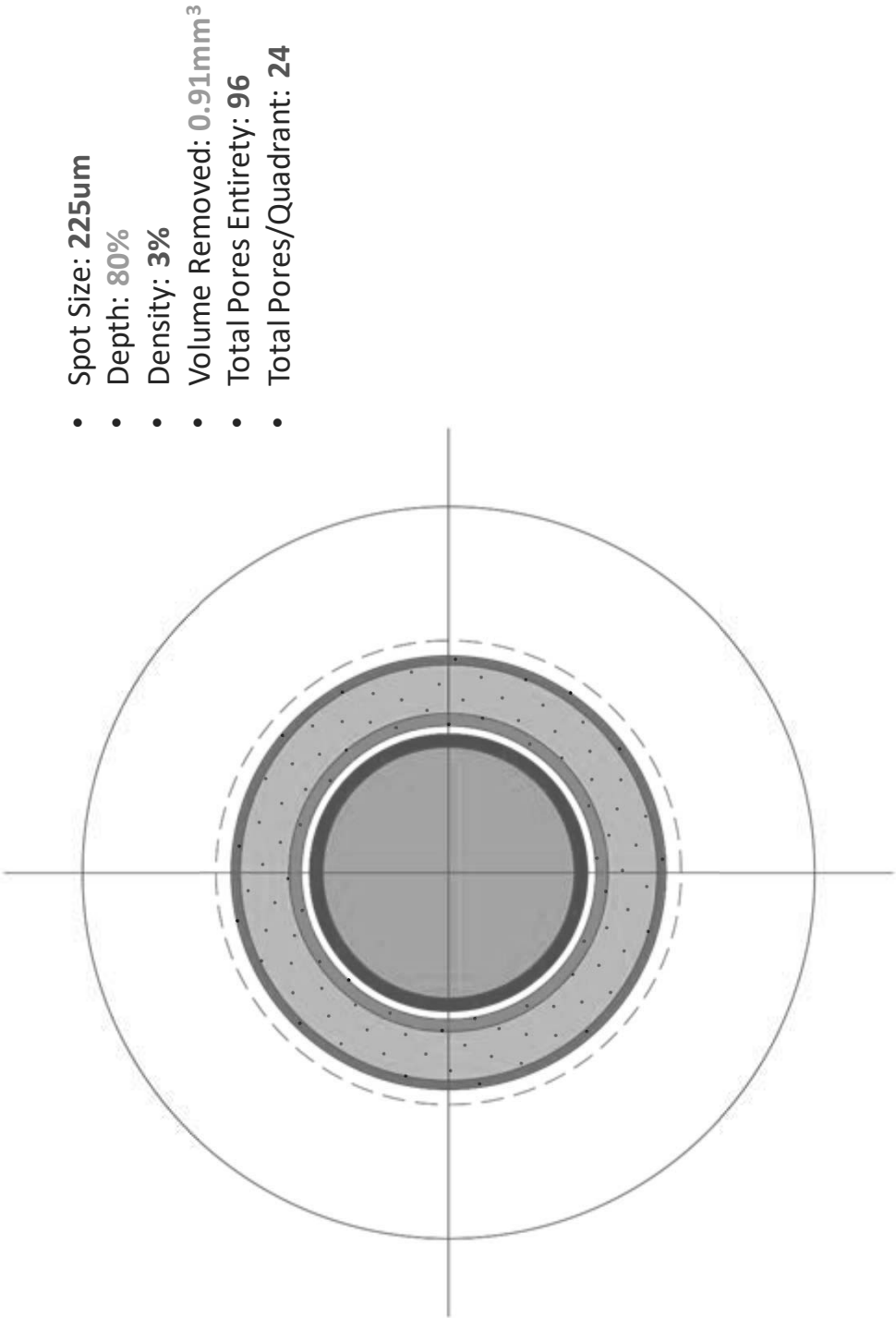


FIG. 2K-2

Protocol 1.2: 225um (161 Total Pores @ 5% = 40.25 Pores/Quadrant: Validated)

- Spot Size: **225um**
- Depth: **80%**
- Density: **5%**
- Volume Removed: **1.52mm³**
- Total Pores Entirety: **161**
- Total Pores/Quadrant: **40.25**

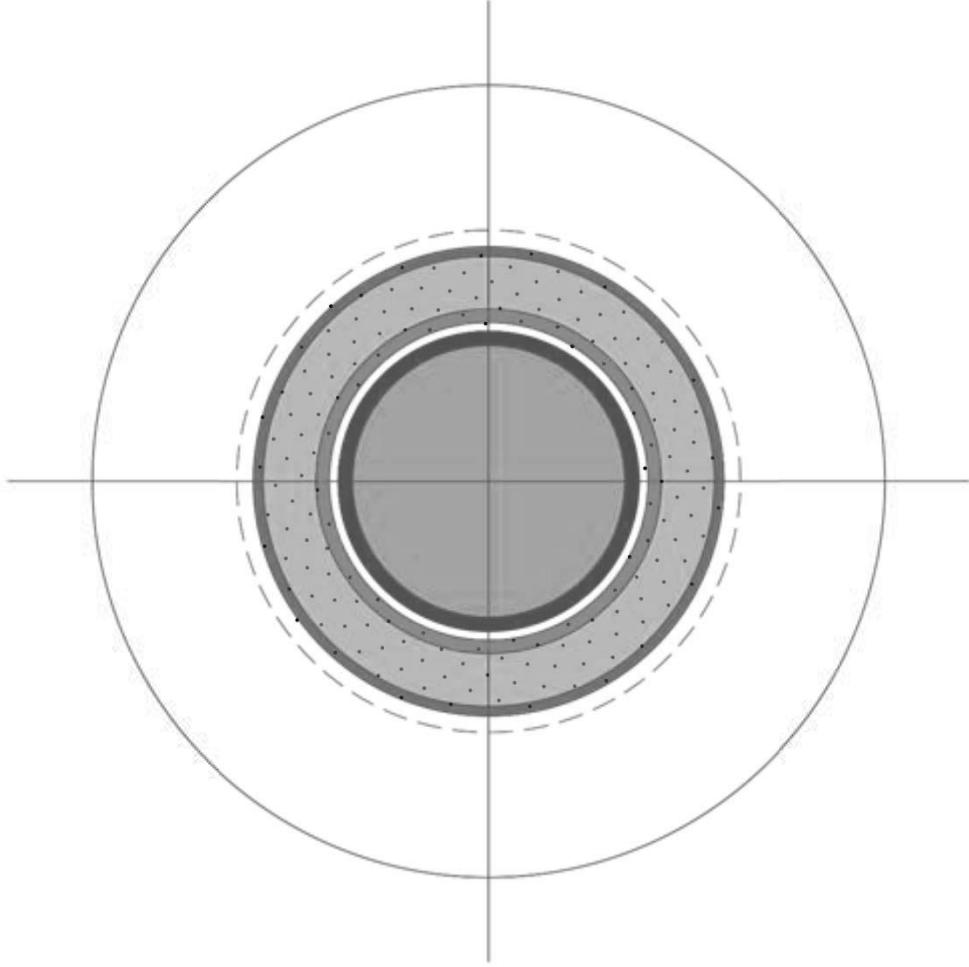


FIG. 2K-3

Protocol 1.3: 225um (257 Total Pores @ 8% = 64.25 Pores/Quadrant: Validated)

- Spot Size: **225um**
- Depth: **80%**
- Density: **8%**
- Volume Removed: **2.43mm³**
- Total Pores Entirety: **257**
- Total Pores/Quadrant: **64.25**

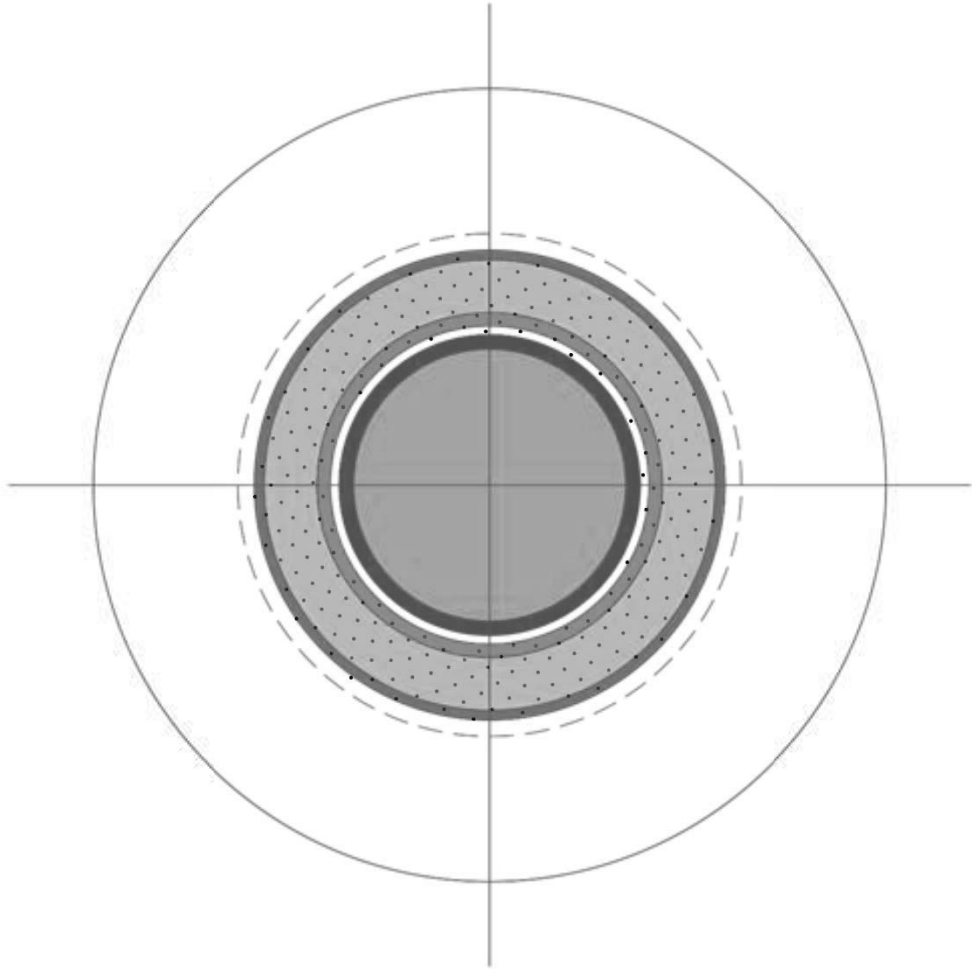


FIG. 2K-4

Protocol 1.4: 225um (565 Total Pores @ 10% = 141.25 Pores/Quadrant: Validated)

- Spot Size: **225um**
- Depth: **80%**
- Density: **10%**
- Volume Removed: **3.04mm³**
- Total Pores Entirety: **565**
- Total Pores/Quadrant: **141.25**

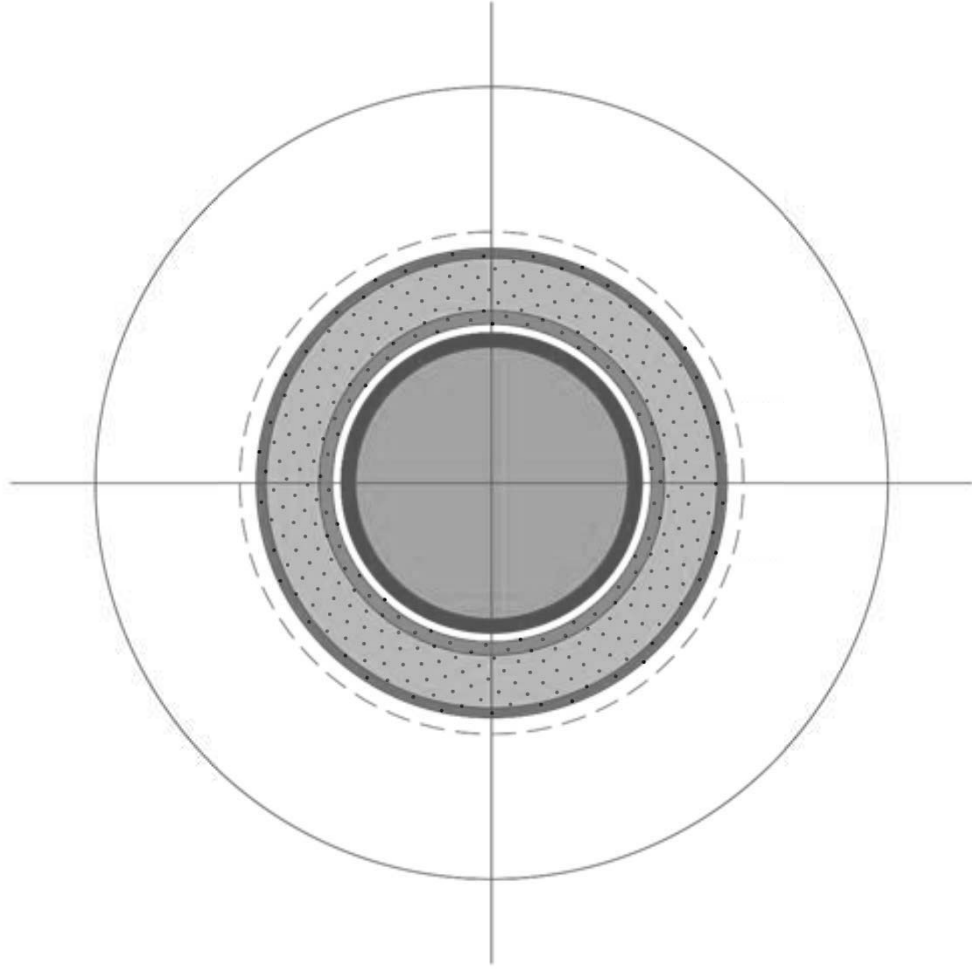


FIG. 2K-5

Protocol 2.1: 250um (100 Total Pores @ 3% = 25 Pores/Quadrant: Validated)

- Spot Size: **250um**
- Depth: **80%**
- Density: **3%**
- Volume Removed: **0.91mm³**
- Total Pores Entirety: **100**
- Total Pores/Quadrant: **25**

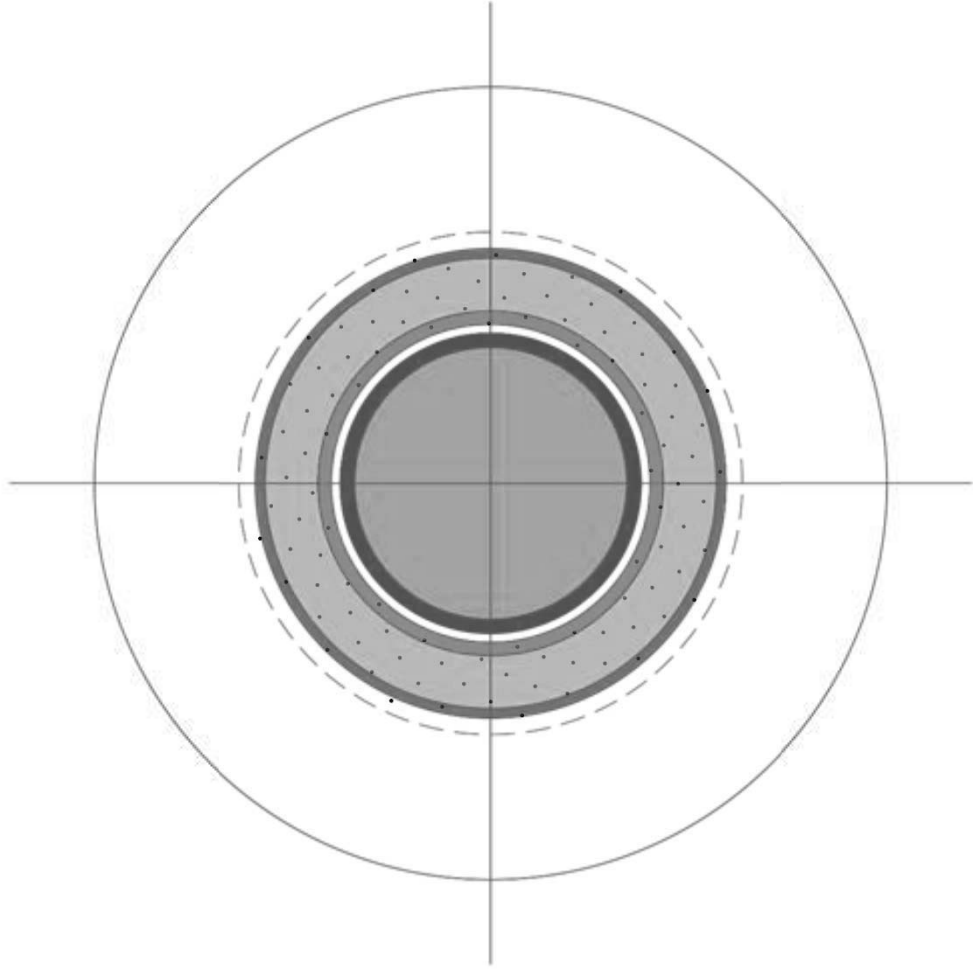


FIG. 2K-6

Protocol 2.2: 250um (166 Total Pores @ 5% = 41.5 Pores/Quadrant: Validated)

- Spot Size: **250um**
- Depth: **80%**
- Density: **5%**
- Volume Removed: **1.52mm³**
- Total Pores Entirety: **166**
- Total Pores/Quadrant: **41.5**

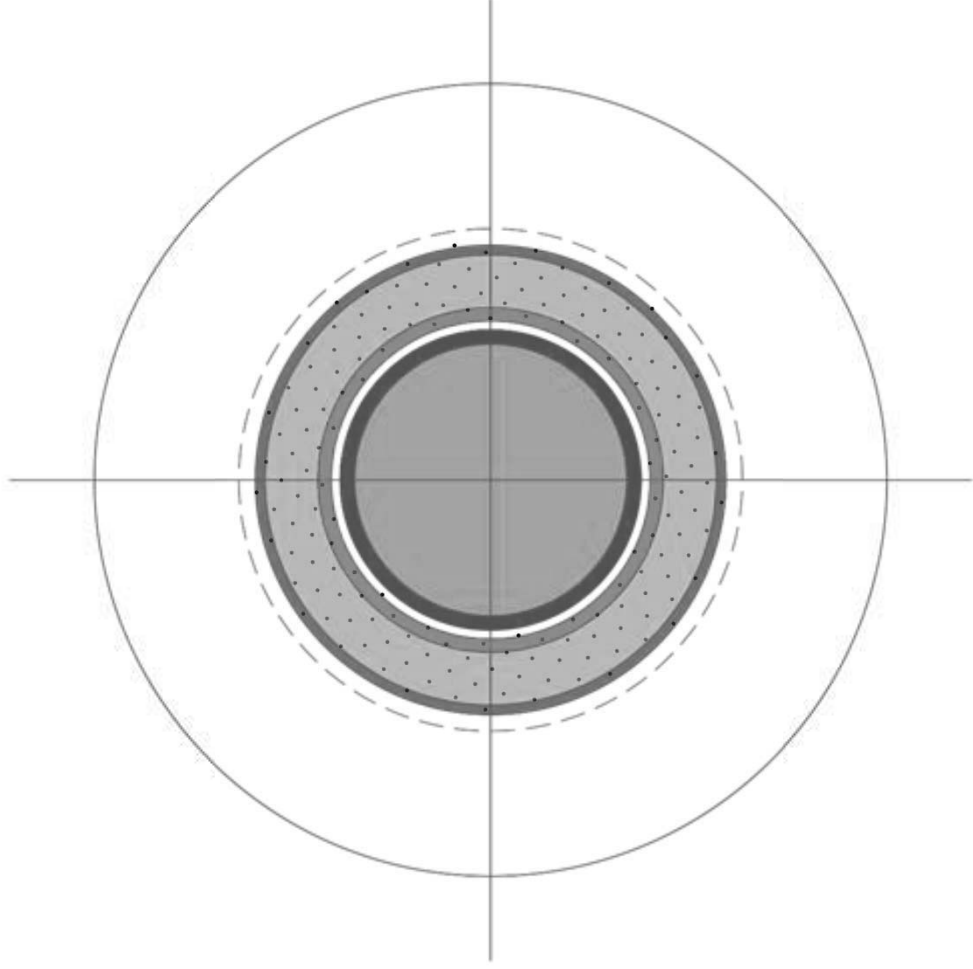


FIG. 2K-7

Protocol 2.3: 250um (265 Total Pores @ 8% = 66.25 Pores/Quadrant: Validated)

- Spot Size: **250um**
- Depth: **80%**
- Density: **8%**
- Volume Removed: **2.43mm³**
- Total Pores Entirety: **265**
- Total Pores/Quadrant: **66.25**

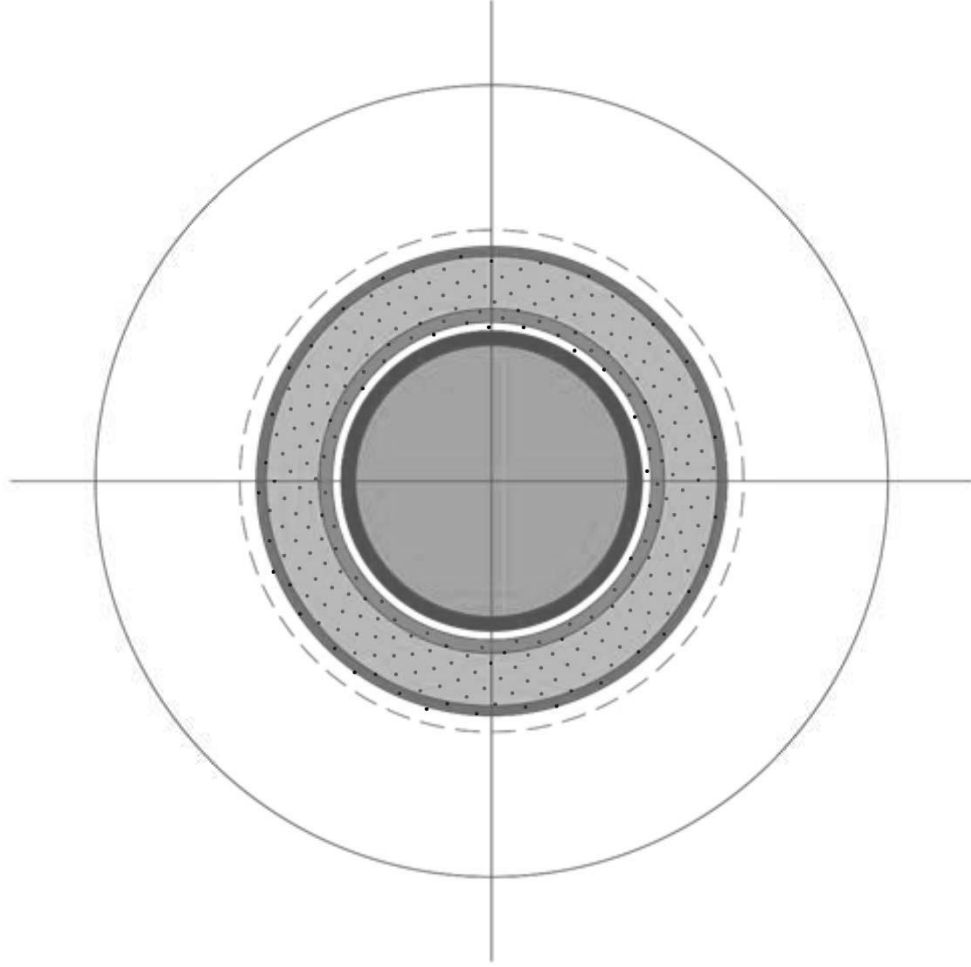


FIG. 2K-8

Protocol 2.4: 250um (332 Total Pores @ 10% = 83 Pores/Quadrant: Validated)

- Spot Size: **250um**
- Depth: **80%**
- Density: **10%**
- Volume Removed: **3.04mm³**
- Total Pores Entirety: **332**
- Total Pores/Quadrant: **83**

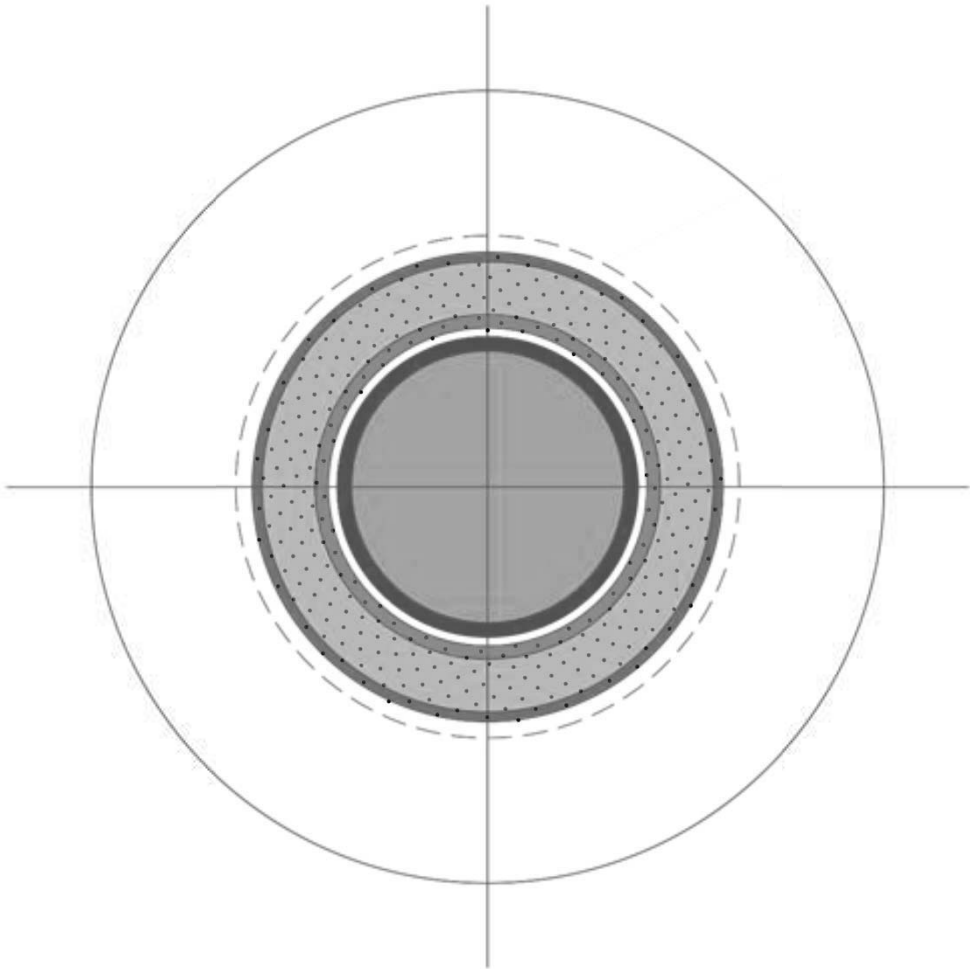


FIG. 2K-9

Protocol 3.1: 325um (59 Total Pores @ 3% = 14.75 Pores/Quadrant: Validated)

- Spot Size: **325um**
- Depth: **80%**
- Density: **3%**
- Volume Removed: **0.91mm³**
- Total Pores Entirety: **59**
- Total Pores/Quadrant: **14.75**

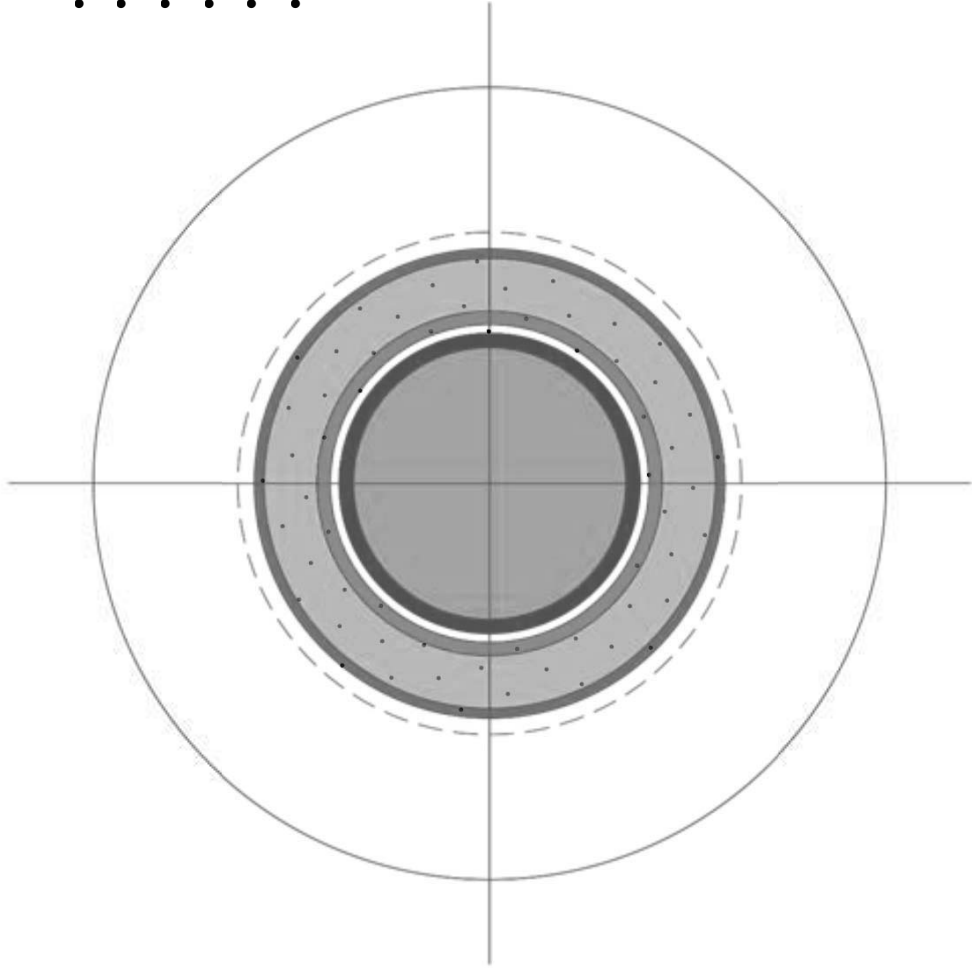


FIG. 2K-10

Protocol 3.2: 325um (98 Total Pores @ 5% = 24.5 Pores/Quadrant: Validated)

- Spot Size: **325um**
- Depth: **80%**
- Density: **5%**
- Volume Removed: **1.52mm³**
- Total Pores Entirety: **98**
- Total Pores/Quadrant: **24.5**

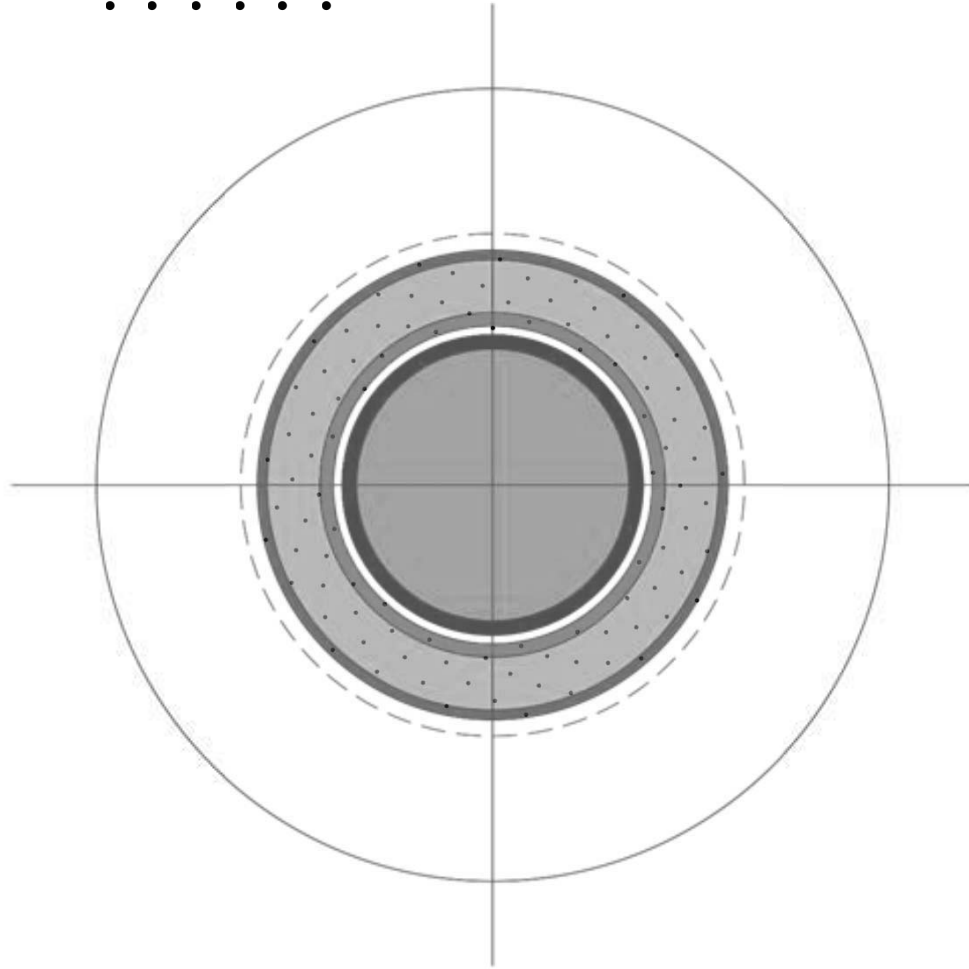


FIG. 2K-11

Protocol 3.3: 325um (157 Total Pores @ 8% = 39.25 Pores/Quadrant: Validated)

- Spot Size: **325um**
- Depth: **80%**
- Density: **8%**
- Volume Removed: **2.43mm³**
- Total Pores Entirety: **157**
- Total Pores/Quadrant: **39.25**

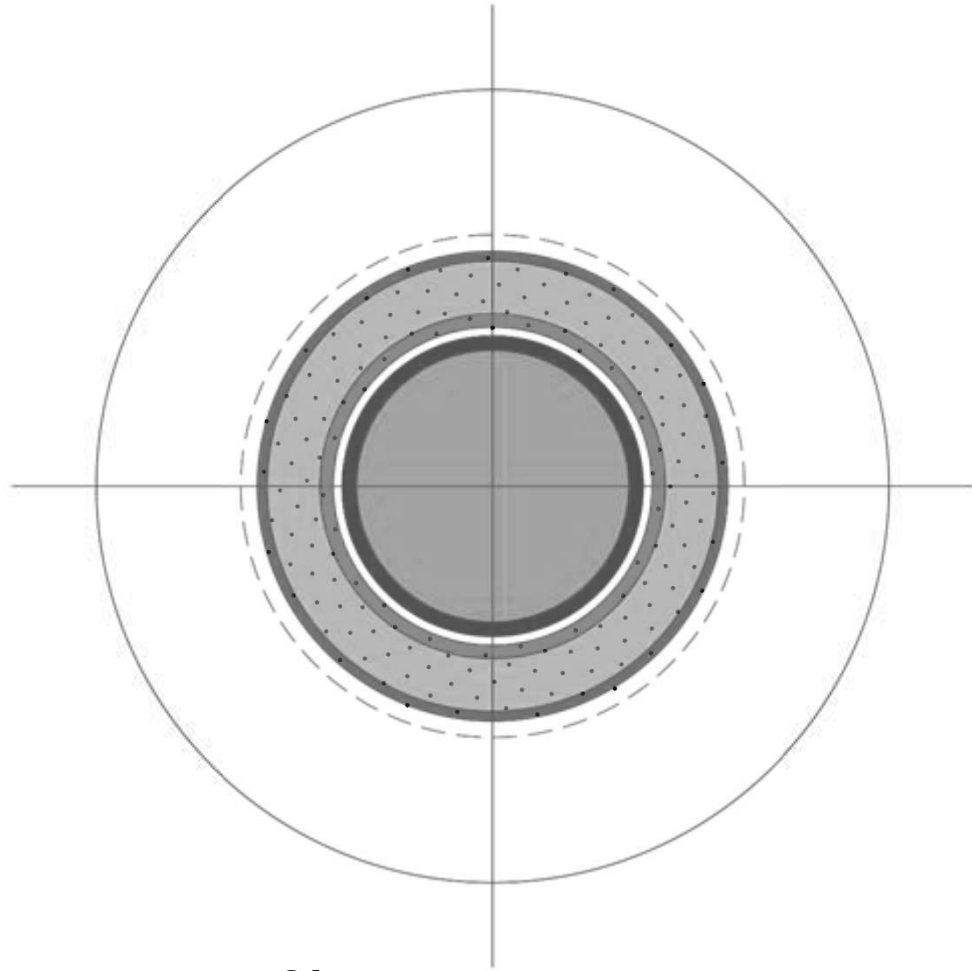


FIG. 2K-12

Protocol 3.4: 325um (196 Total Pores @ 10% = 49 Pores/Quadrant: Validated)

- Spot Size: **325um**
- Depth: **80%**
- Density: **10%**
- Volume Removed: **3.04mm³**
- Total Pores Entirety: **196**
- Total Pores/Quadrant: **49**

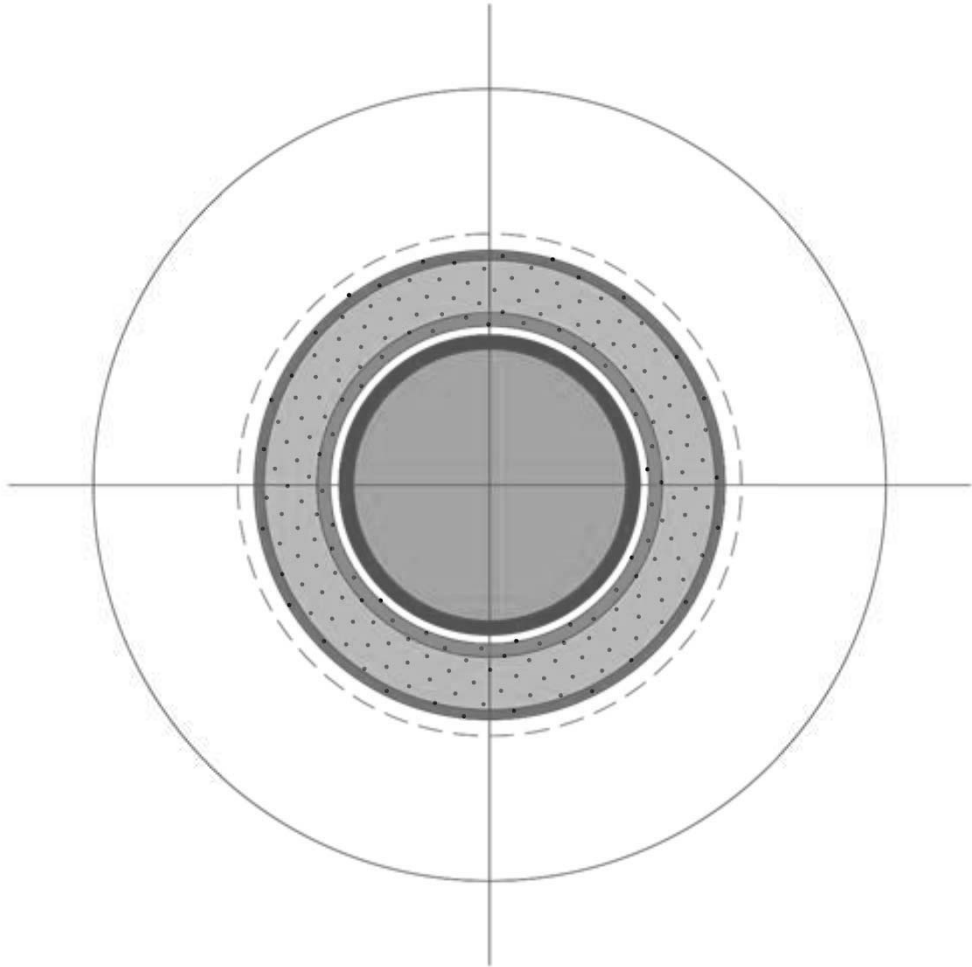


FIG. 2K-13

Protocol 4.1: 425um (34 Total Pores @ 3% = 8.5 Pores/Quadrant: Validated)

- Spot Size: **425um**
- Depth: **80%**
- Density: **3%**
- Volume Removed: **0.91mm³**
- Total Pores Entirety: **34**
- Total Pores/Quadrant: **8.5**

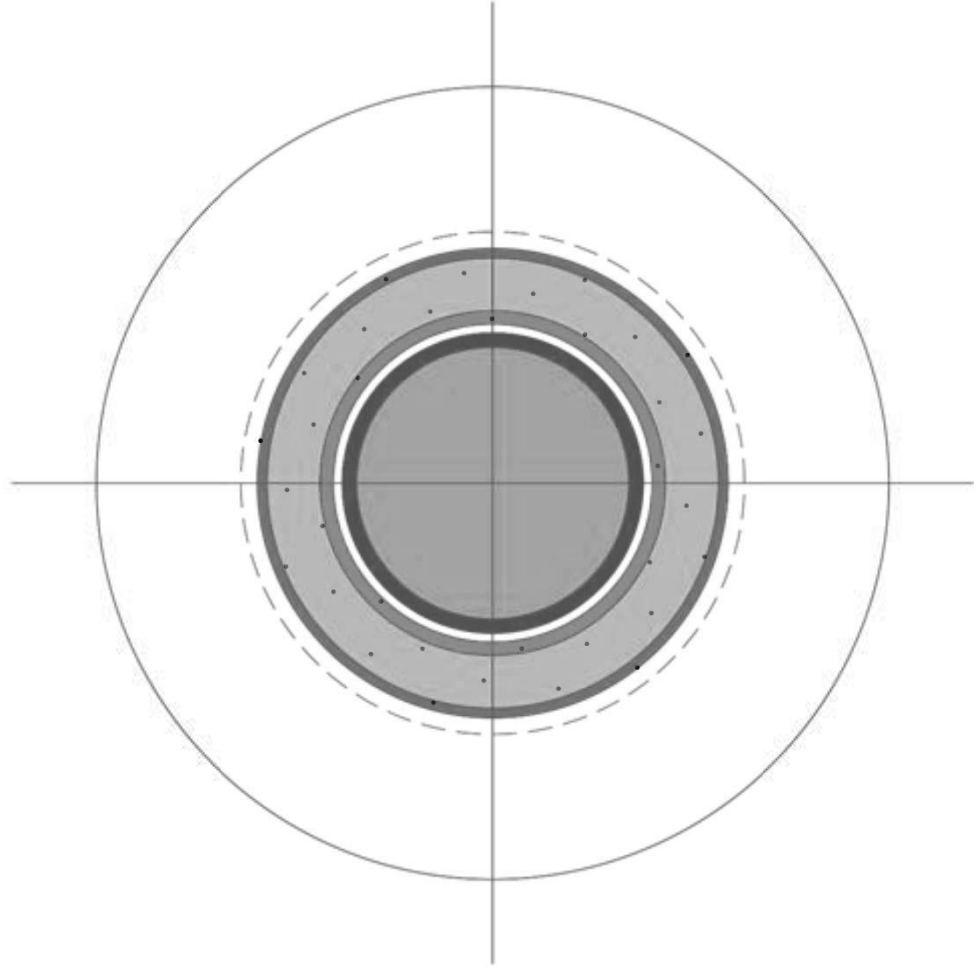


FIG. 2K-14

Protocol 4.2: 425um (57 Total Pores @ 5% = 14.25 Pores/Quadrant: Validated)

- Spot Size: **425um**
- Depth: **80%**
- Density: **5%**
- Volume Removed: **1.52mm³**
- Total Pores Entirety: **57**
- Total Pores/Quadrant: **14.25**

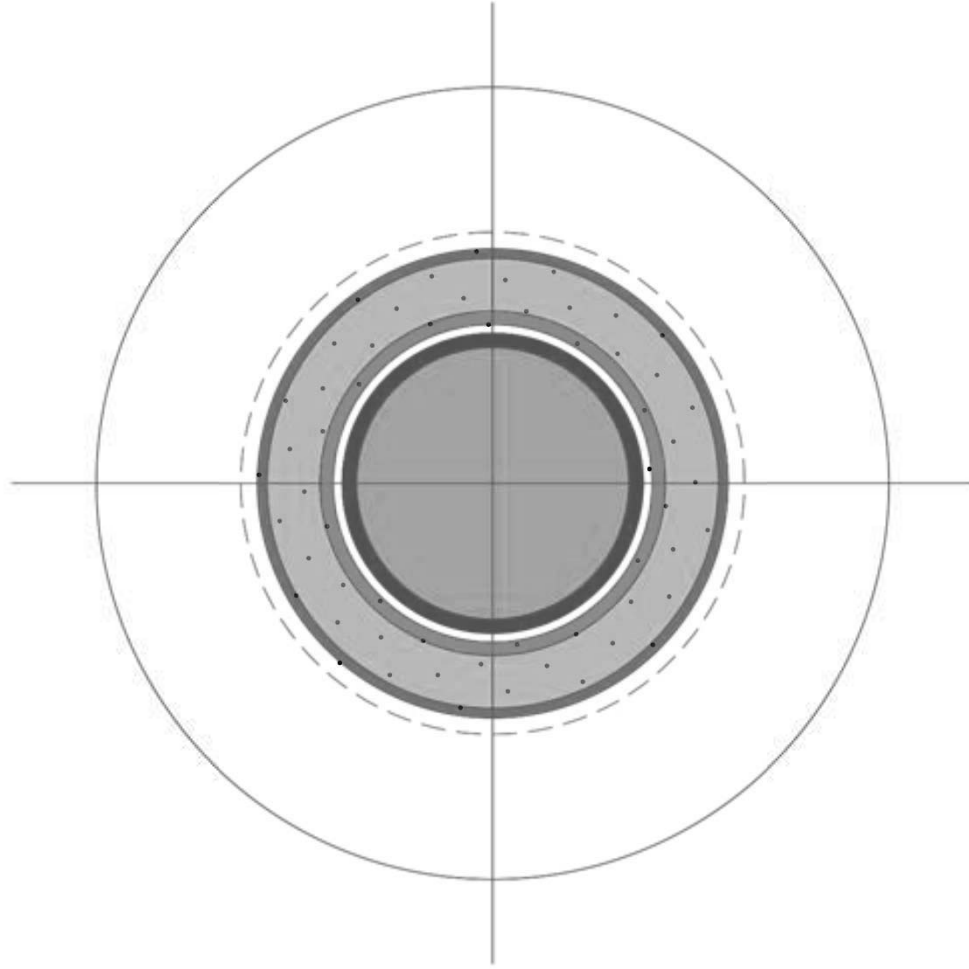


FIG. 2K-15

Protocol 4.3: 425um (92 Total Pores @ 8% = 23 Pores/Quadrant: Validated)

- Spot Size: **425um**
- Depth: **80%**
- Density: **8%**
- Volume Removed: **2.43mm³**
- Total Pores Entirety: **92**
- Total Pores/Quadrant: **23**

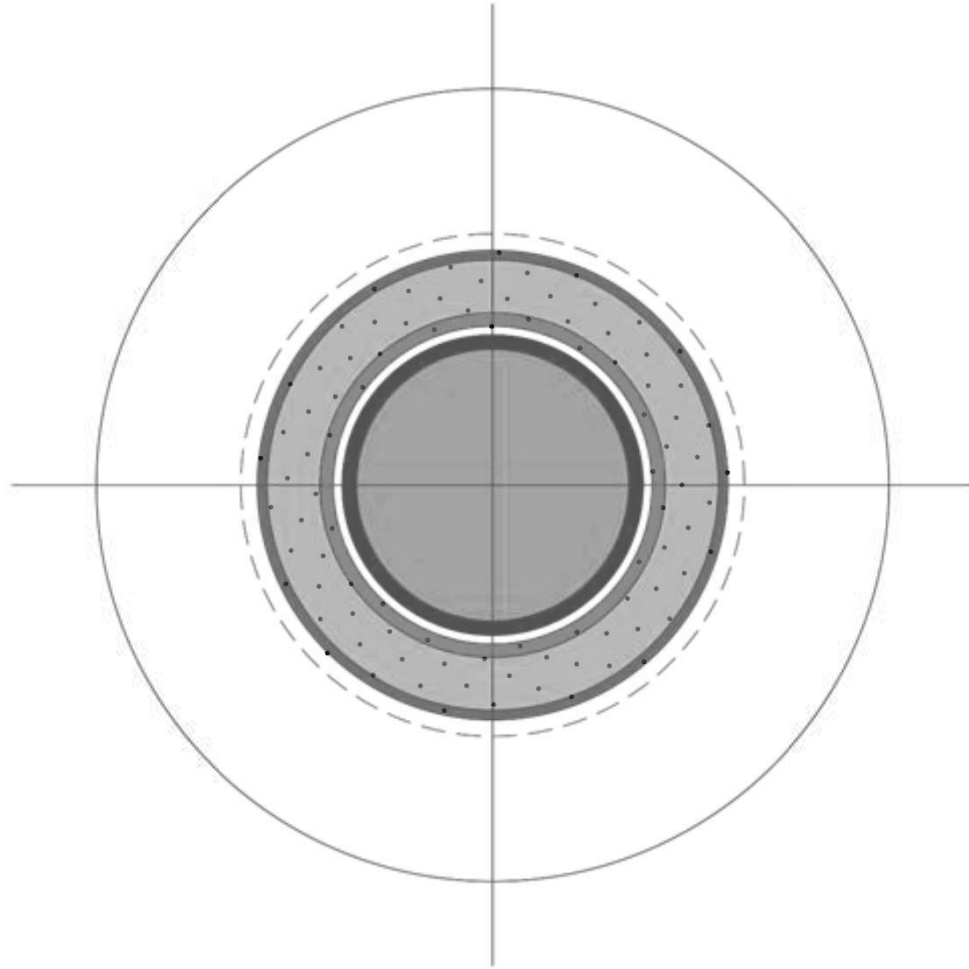


FIG. 2K-16

(0273 amd 0274)
Protocol 4.4: 425um (115 Total Pores @ 10% = 28.75 Pores/Quadrant: Validated)

- Spot Size: **425um**
- Depth: **80%**
- Density: **10%**
- Volume Removed: **3.04mm³**
- Total Pores Entirety: **115**
- Total Pores/Quadrant: **28.75**

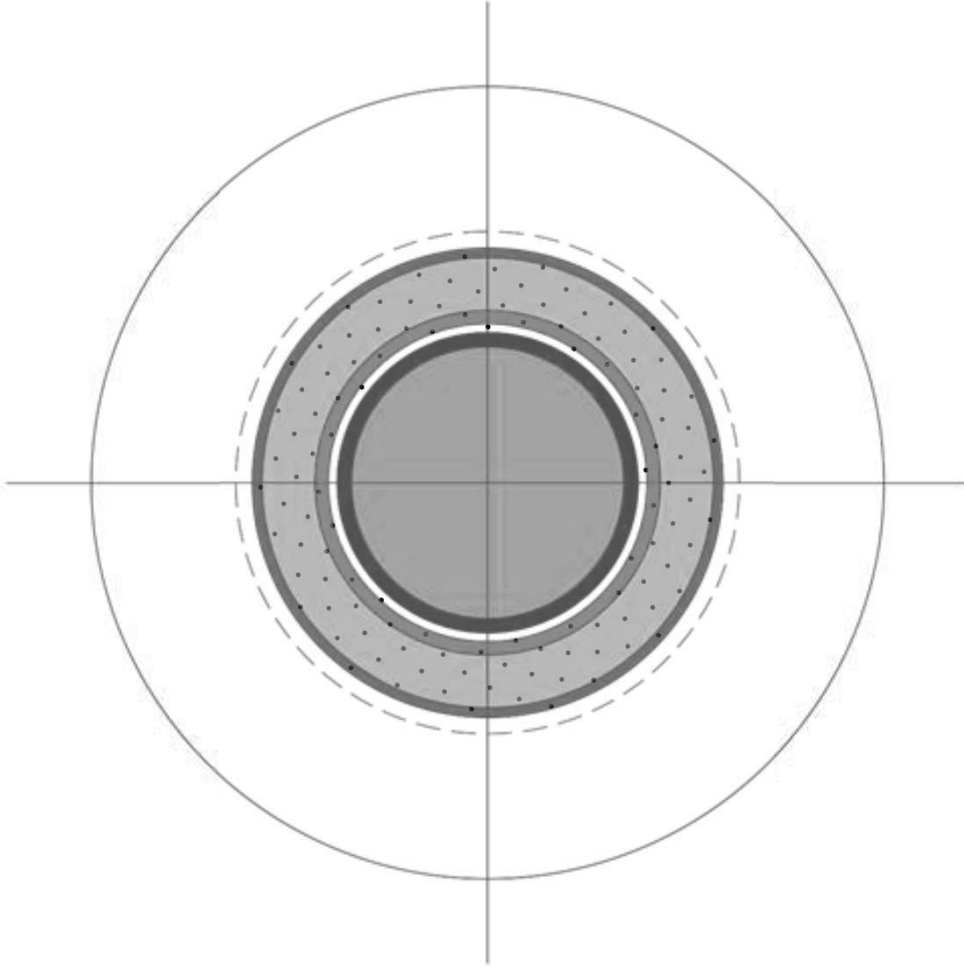


FIG. 2K-17

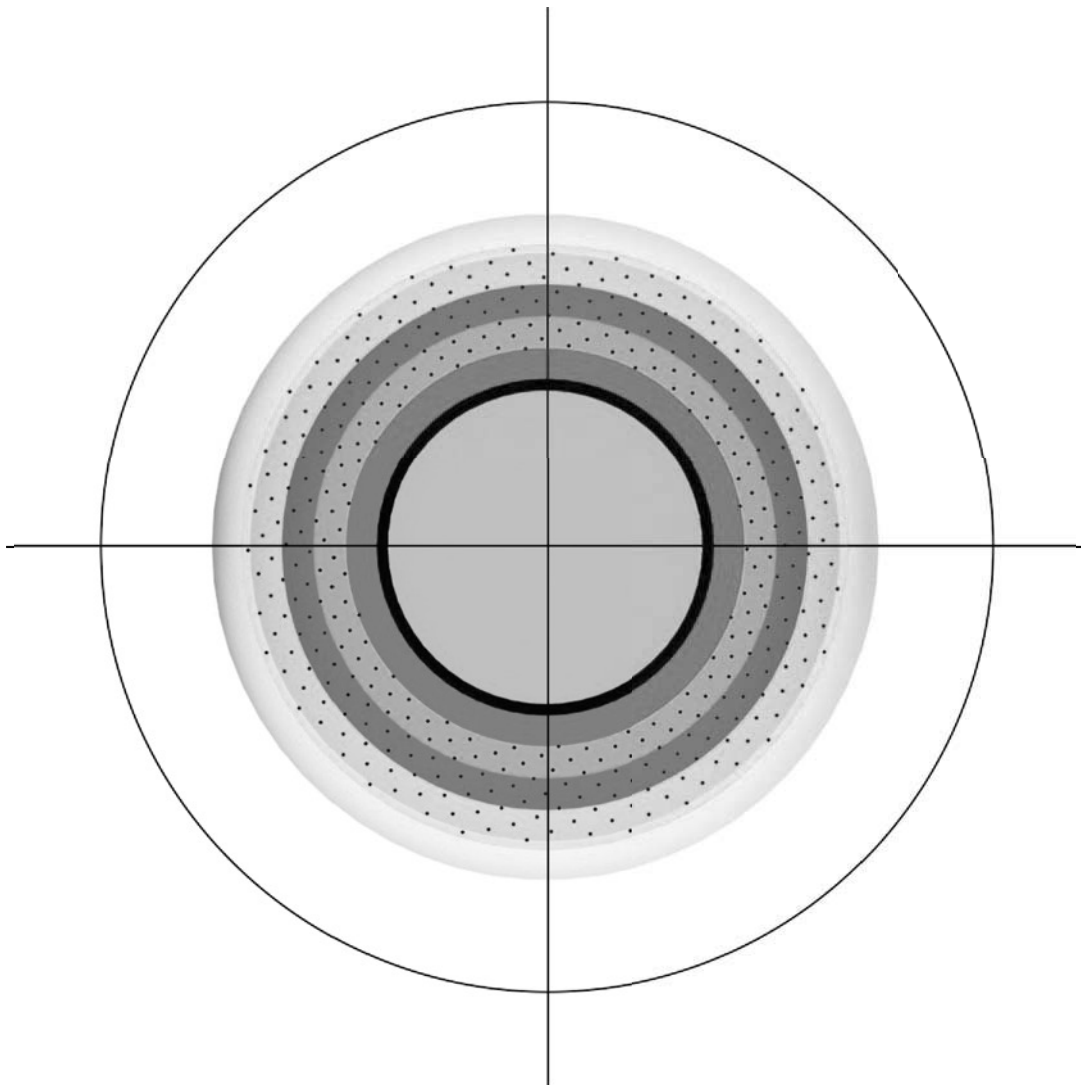
**FIG. 2K-18**



FIG. 2K-19

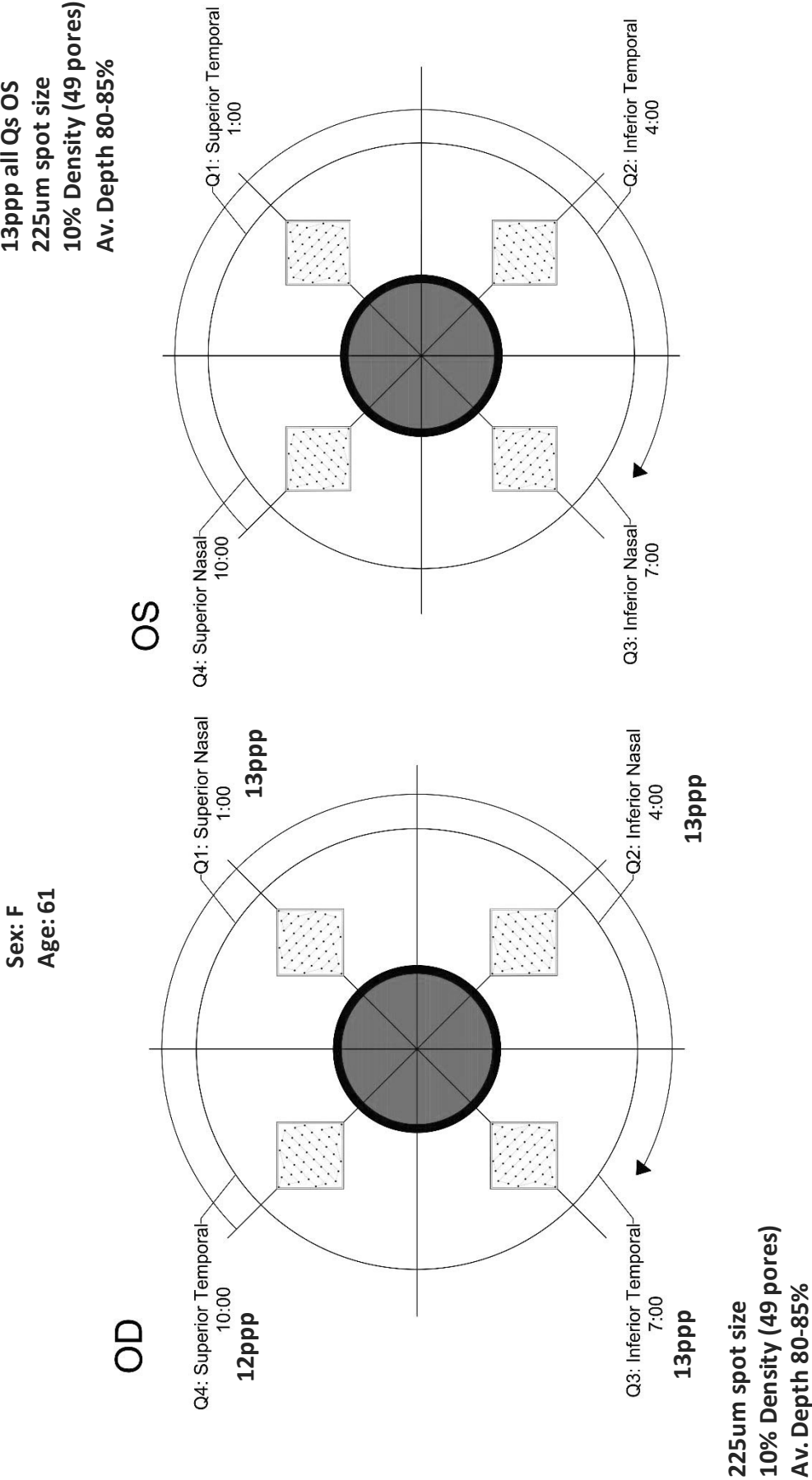


FIG. 2K-20

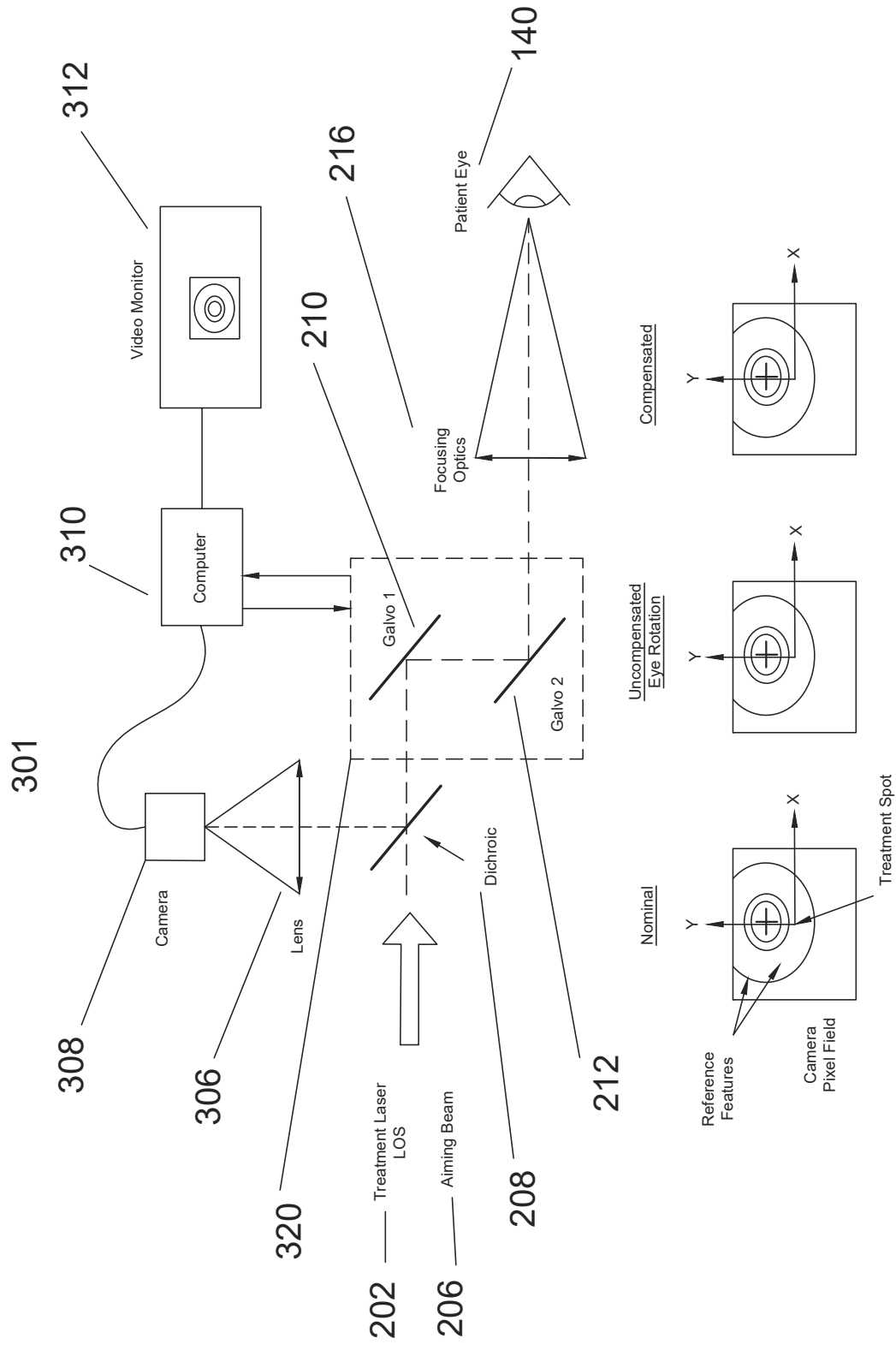


FIG. 3A

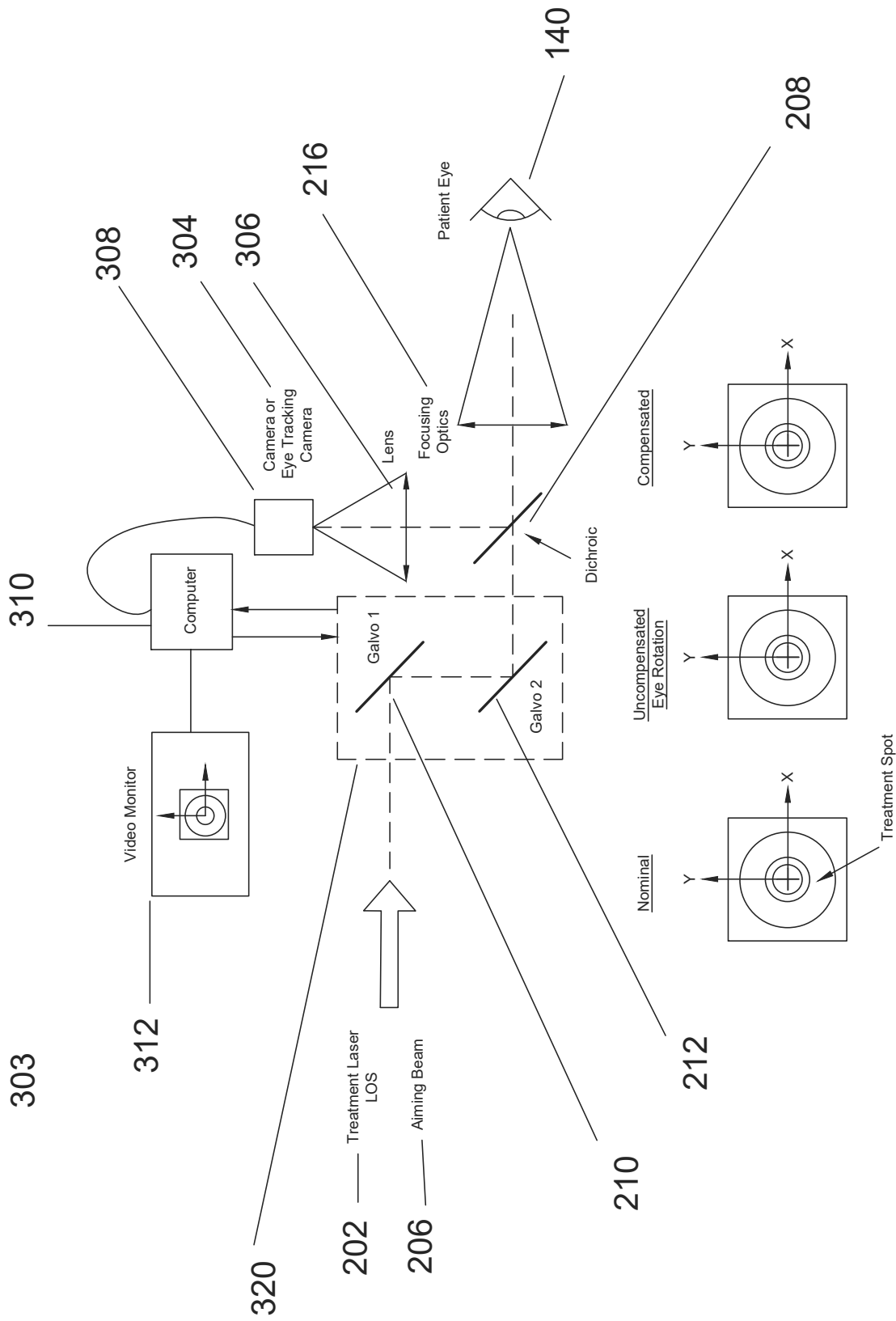


FIG. 3B

Bio-Feedback Controls

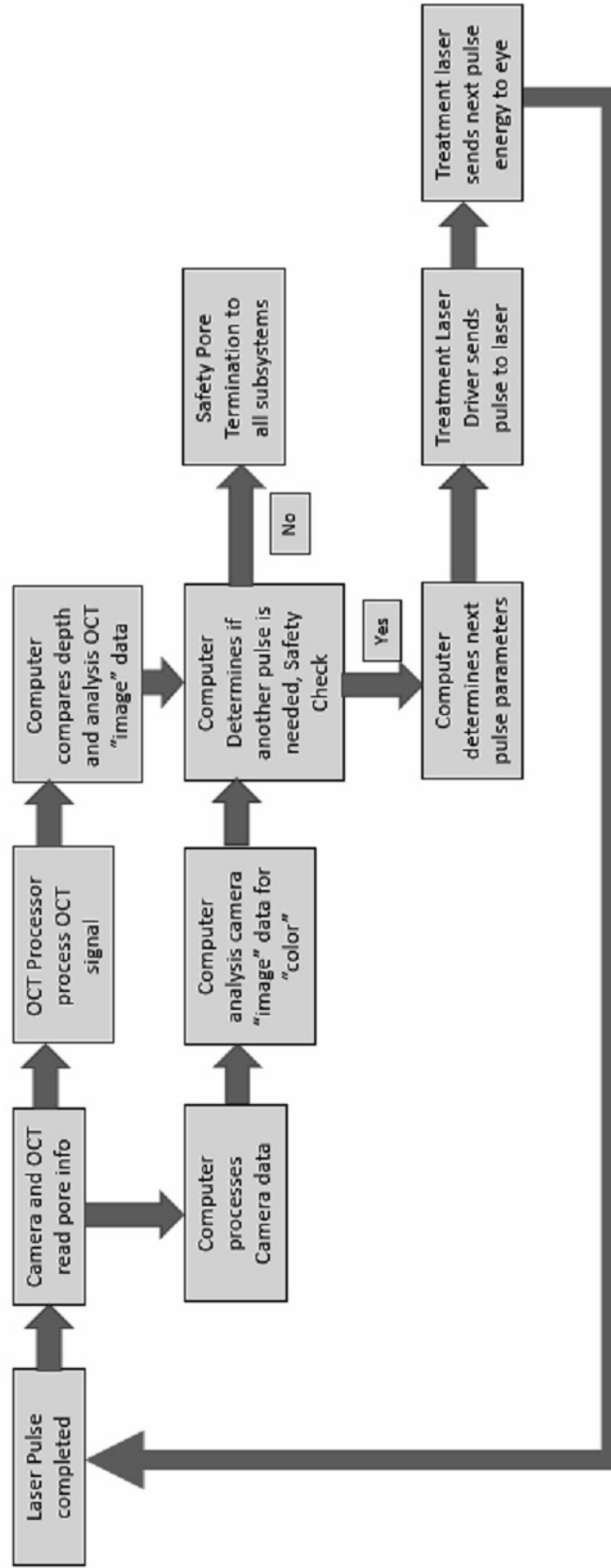


FIG. 3B-1

390

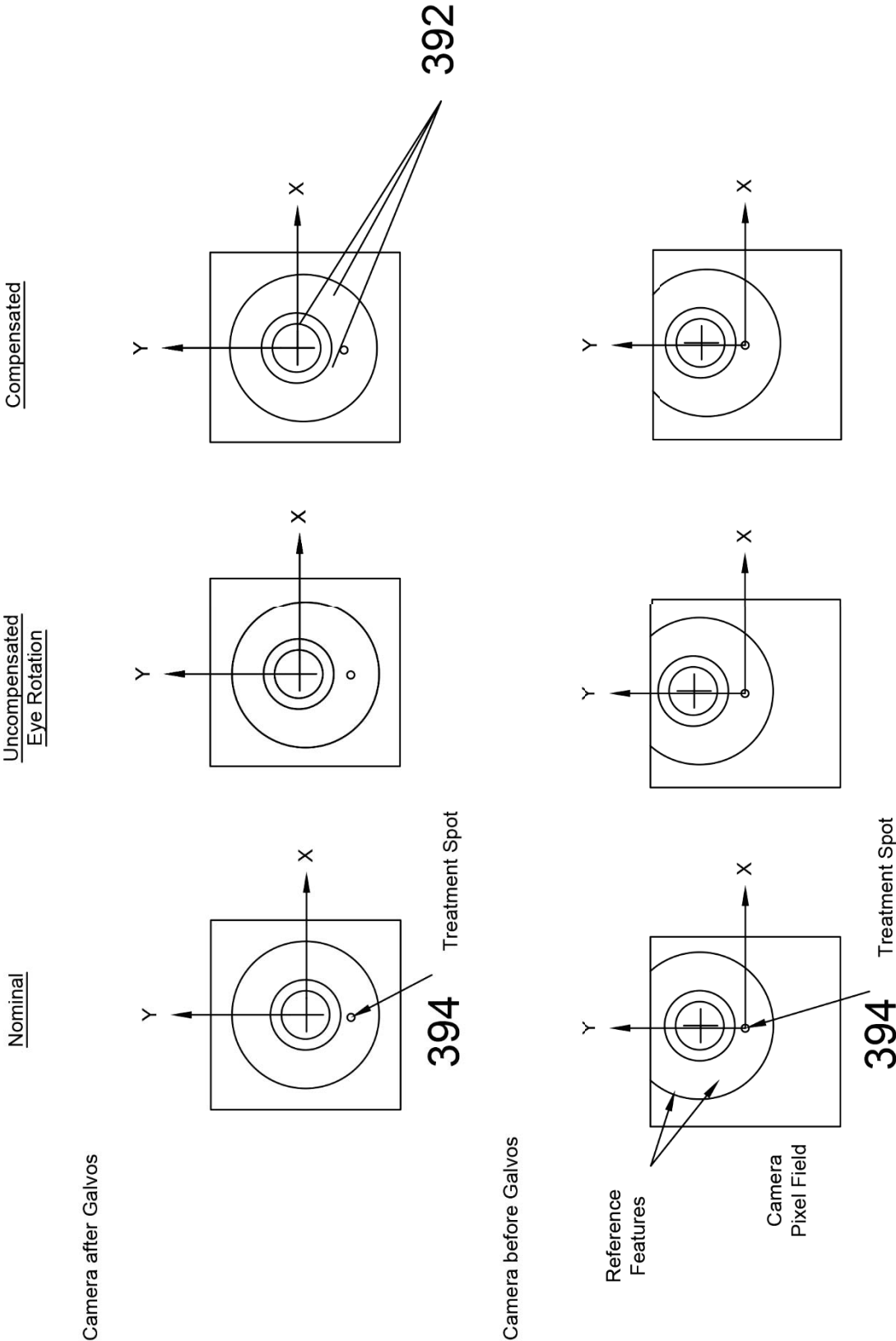


FIG. 3C

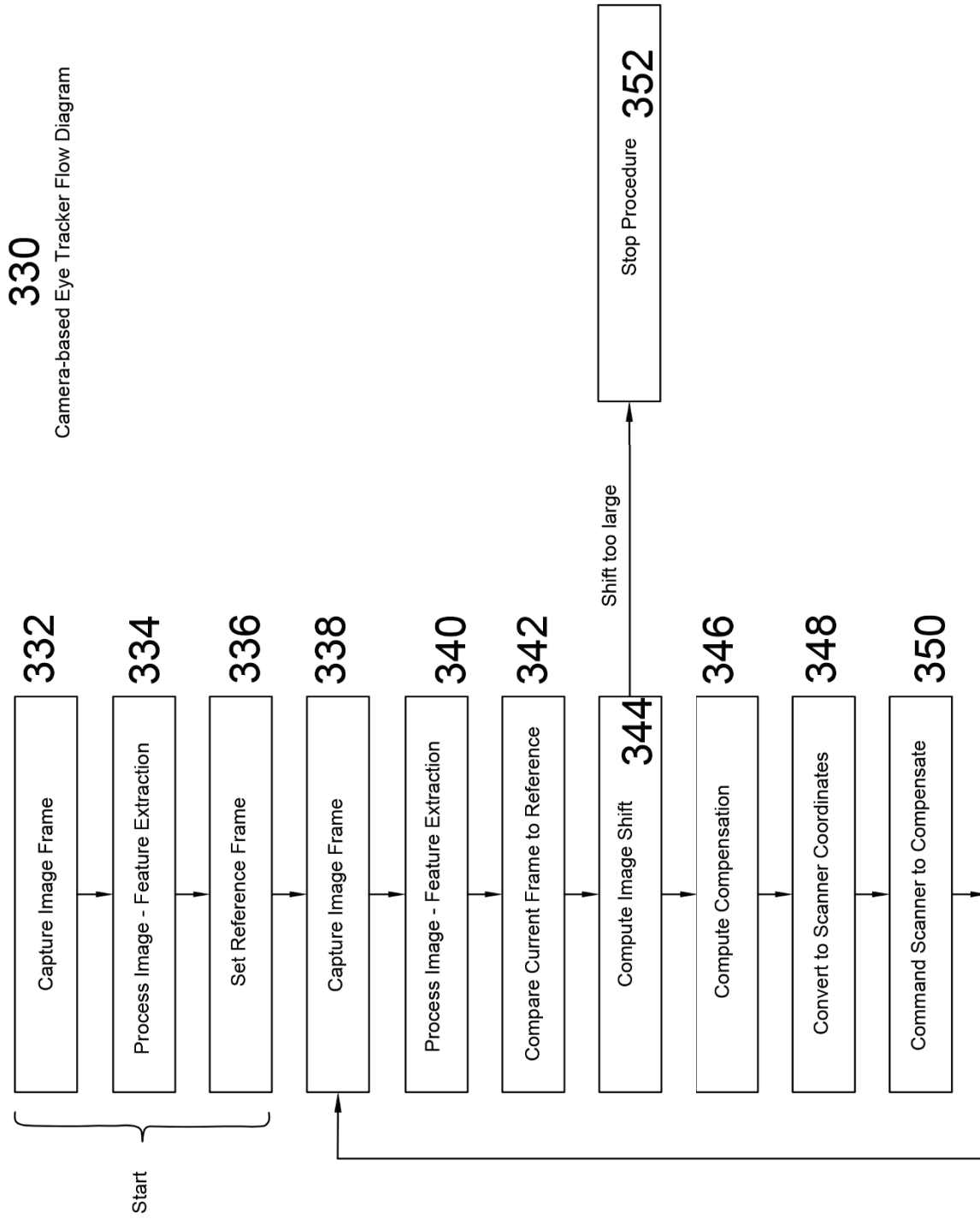


FIG. 3D

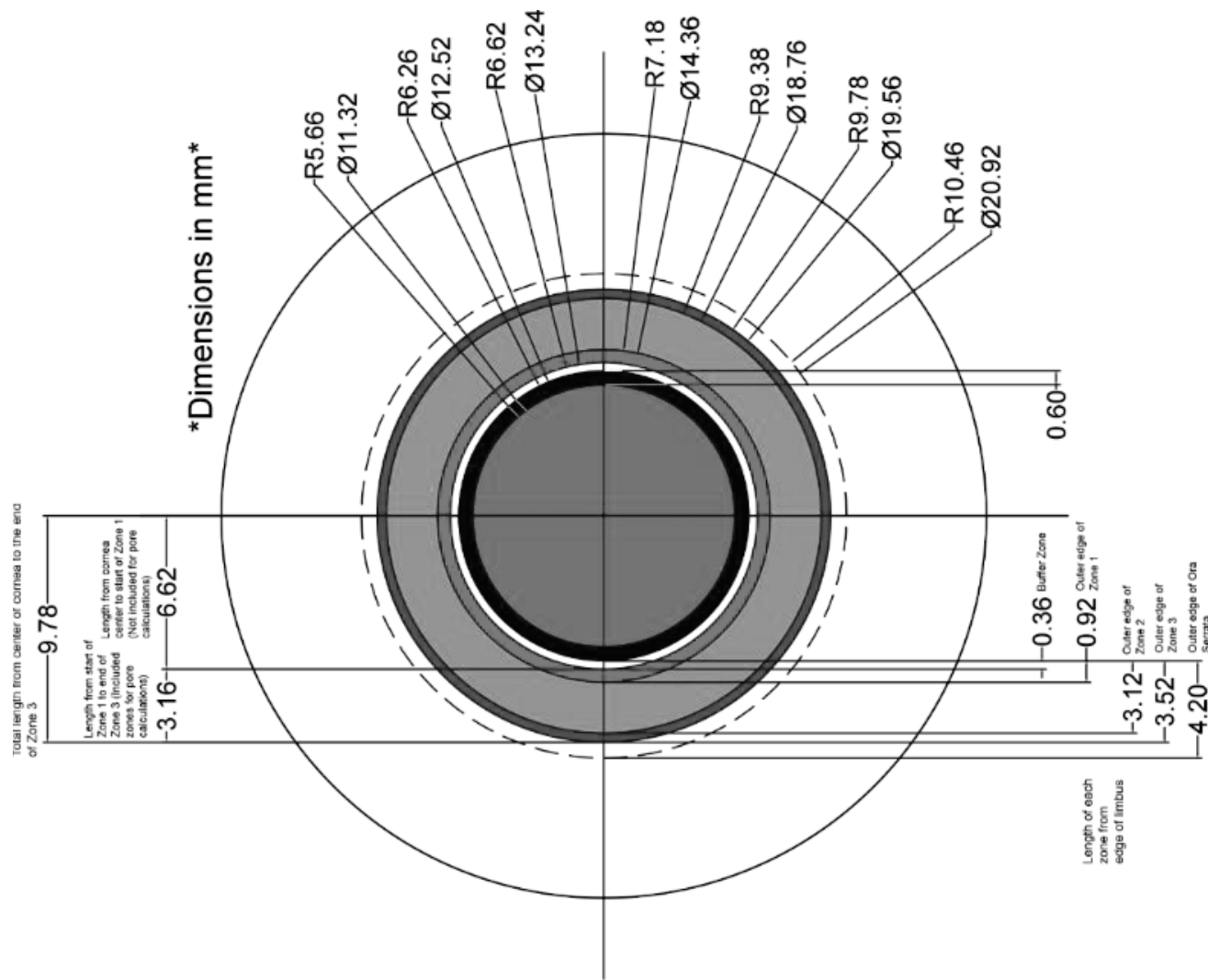


FIG. 4A-1

Dimensions of Scleral Microporation & Lens zones.

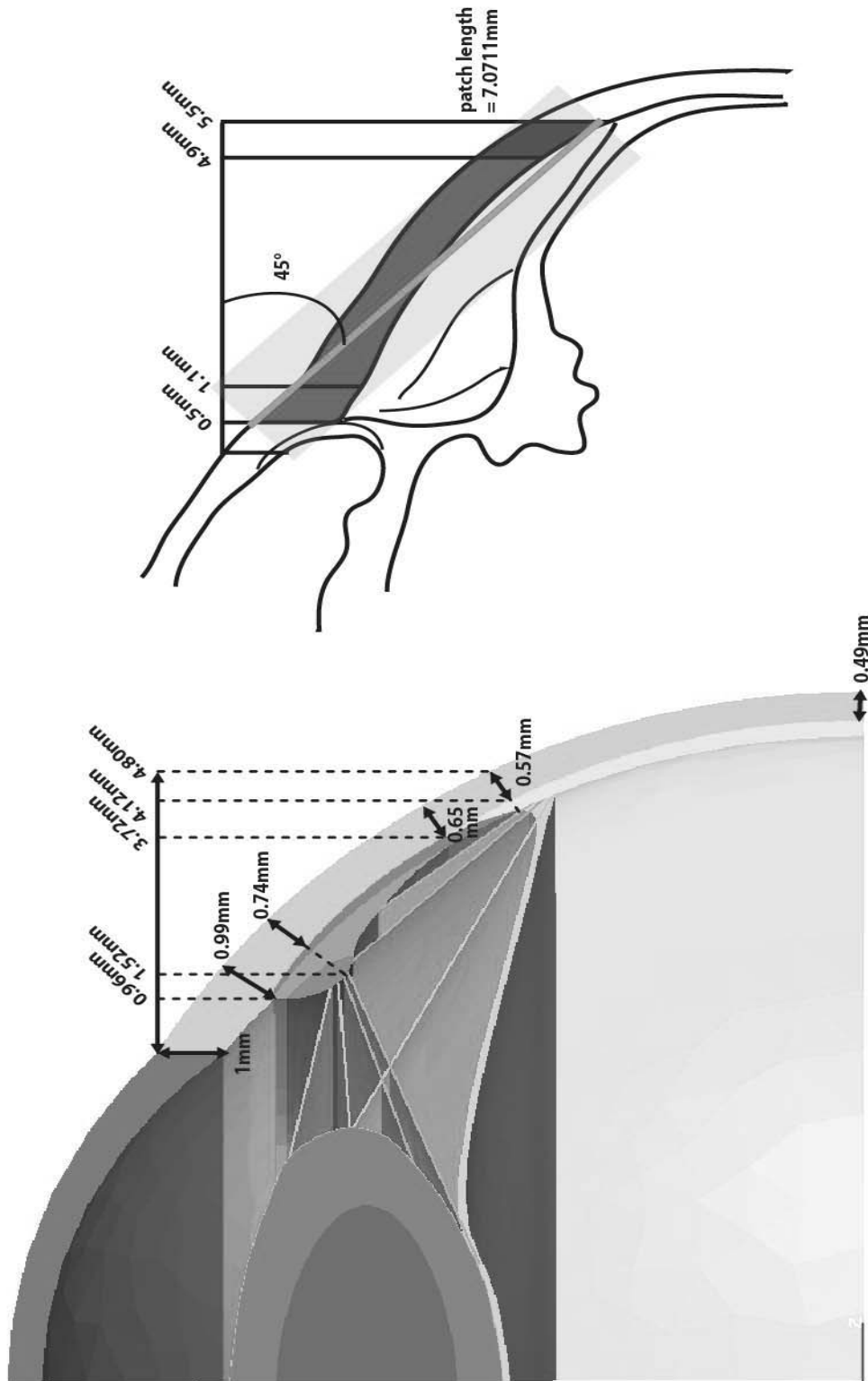
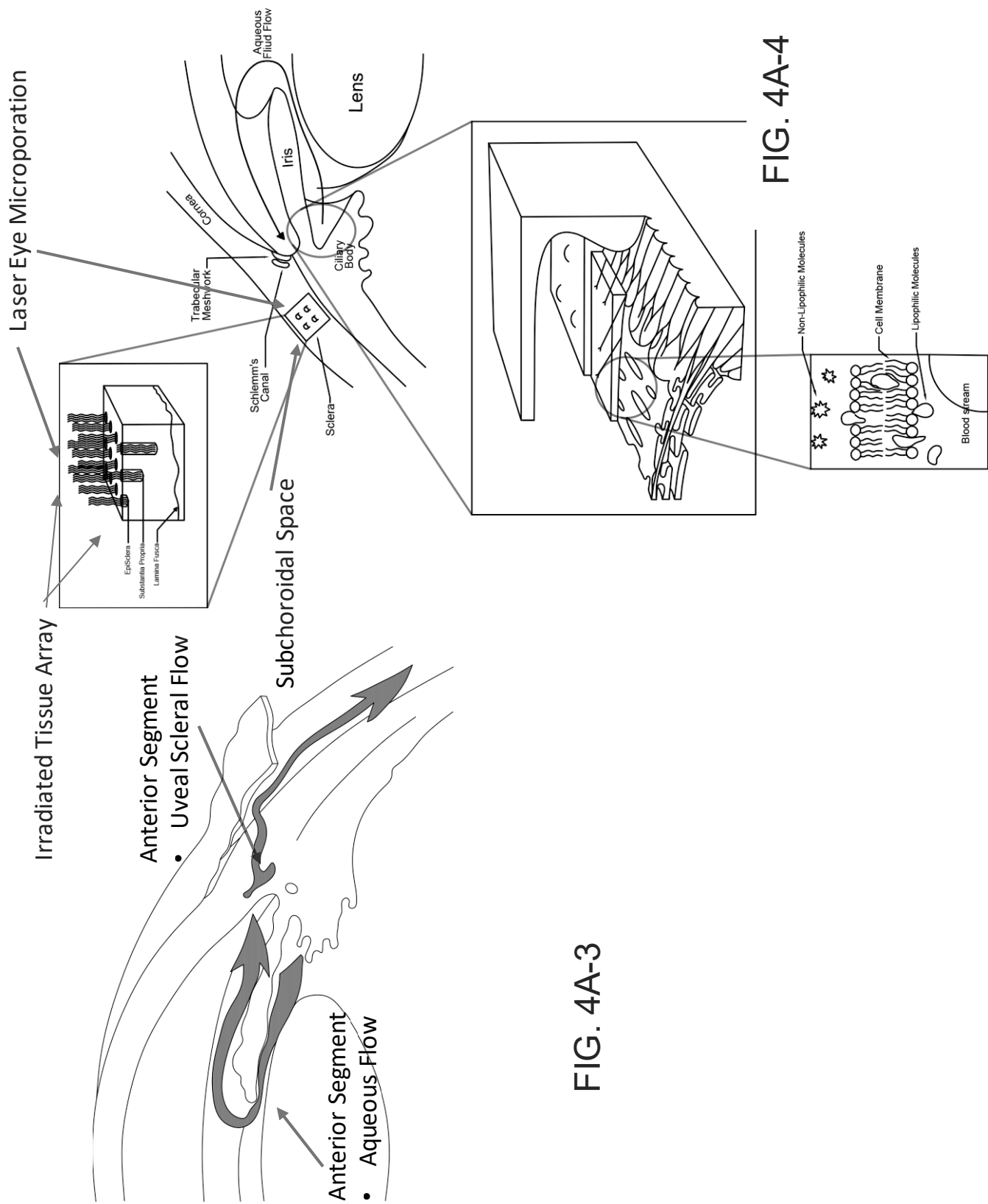


FIG. 4A-2



Sclera Depth Diagram

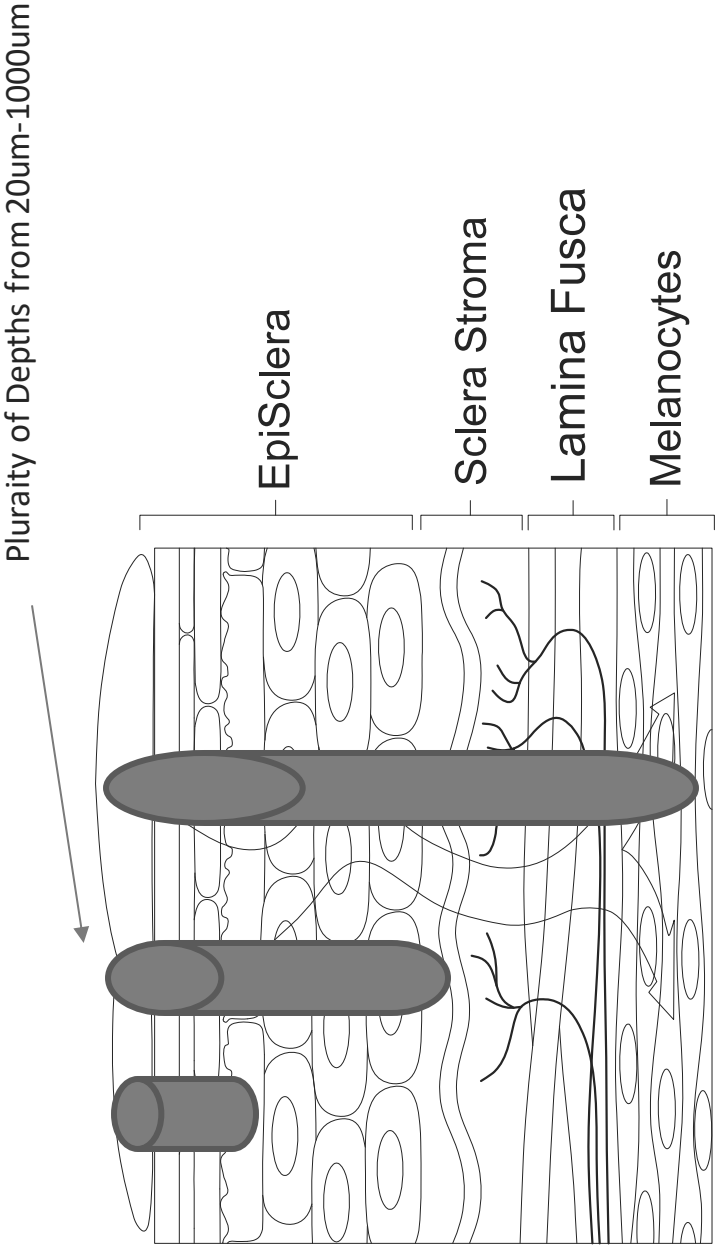
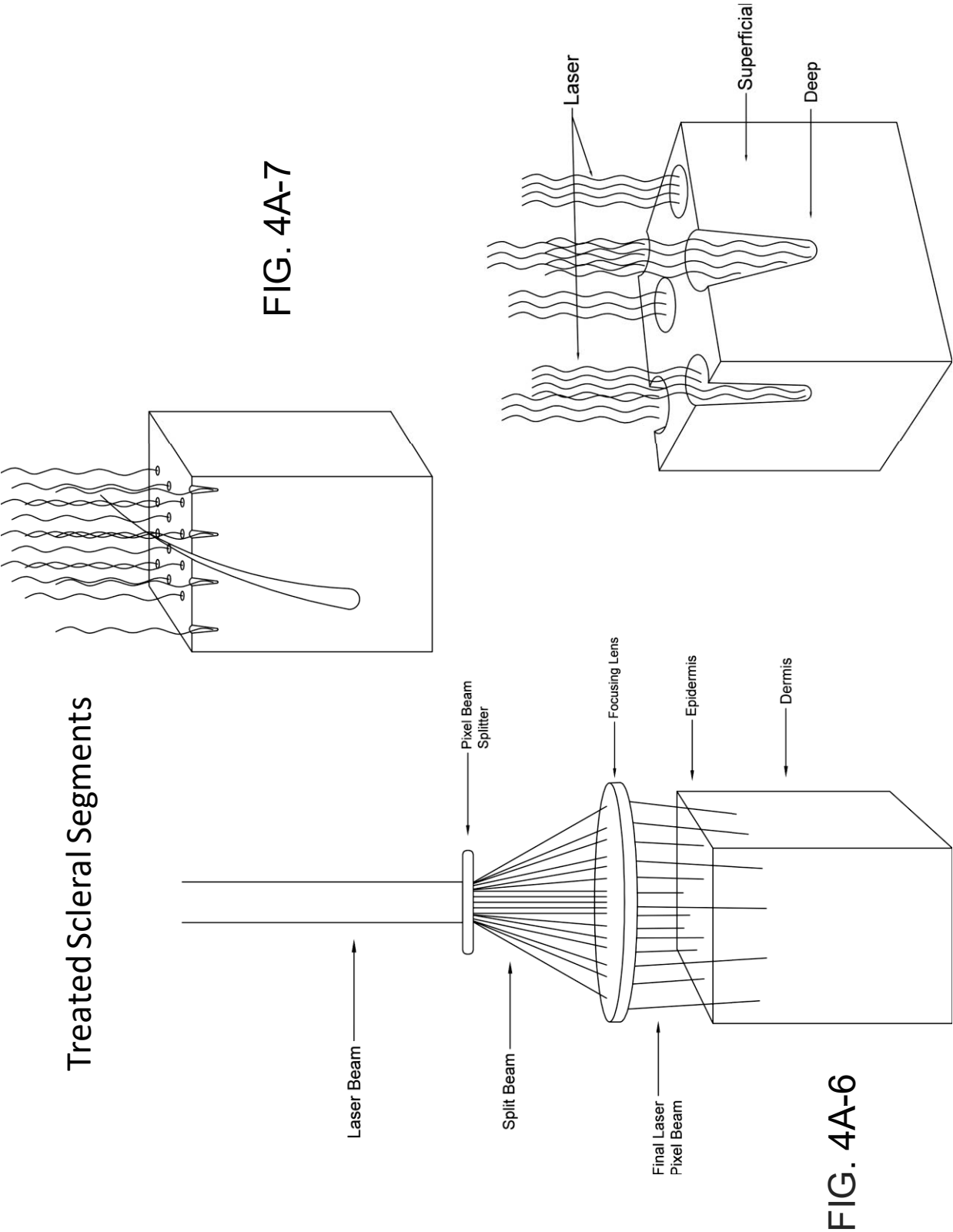


FIG. 4A-5



Targeted Array of Scleral Tissue for Rejuvenation

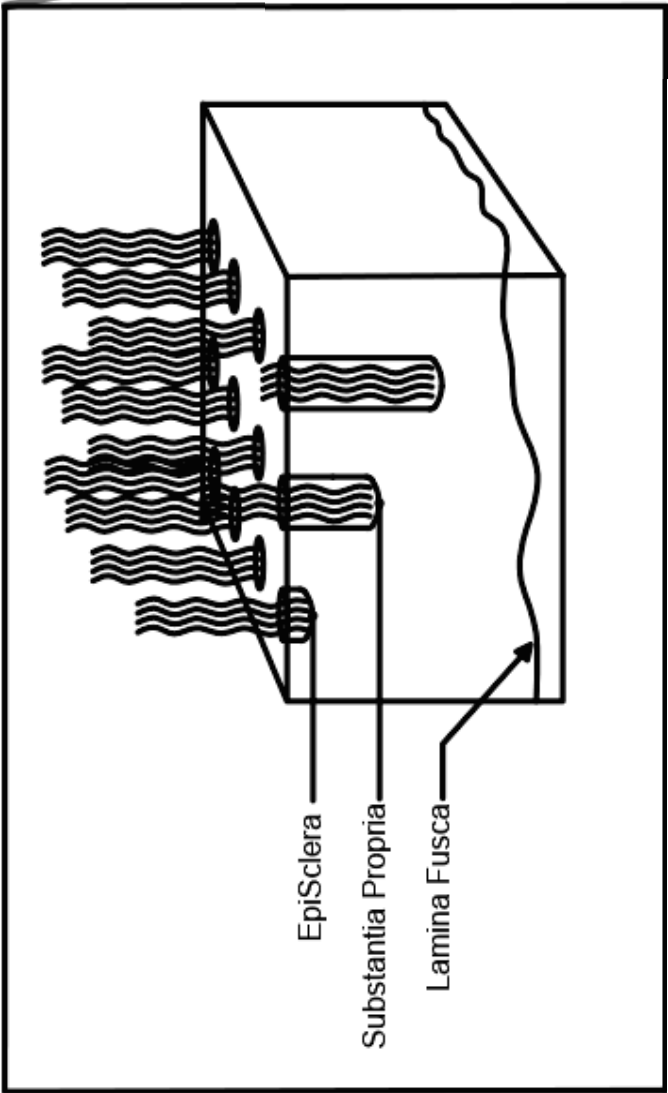


FIG. 4A-9

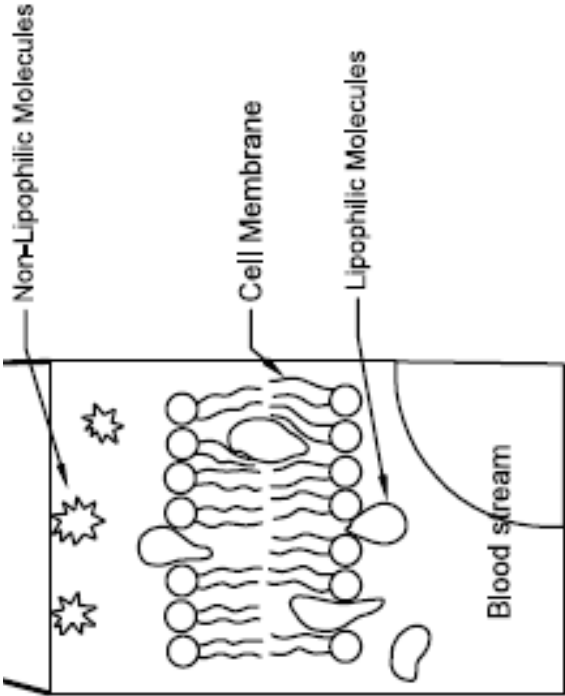
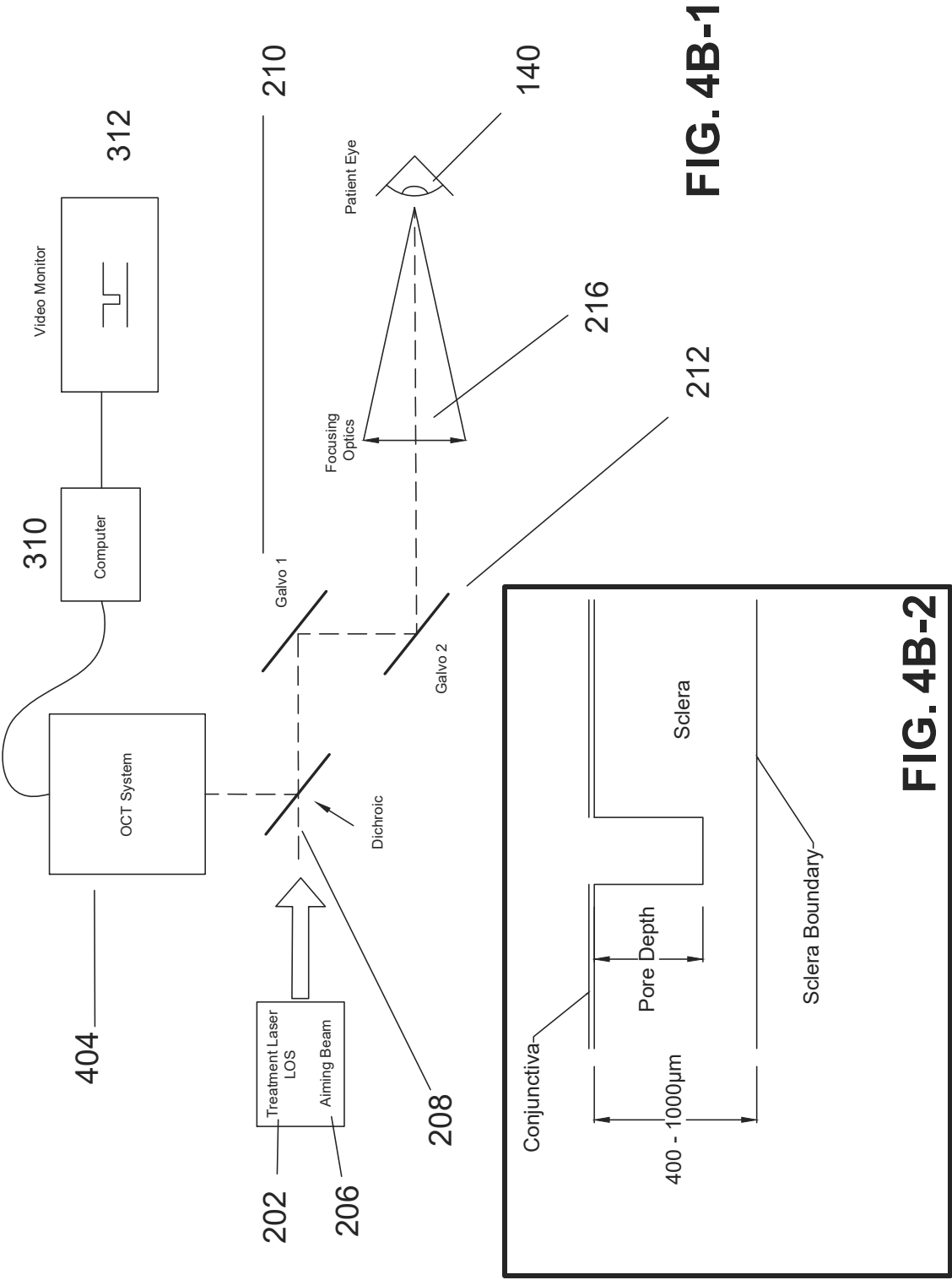
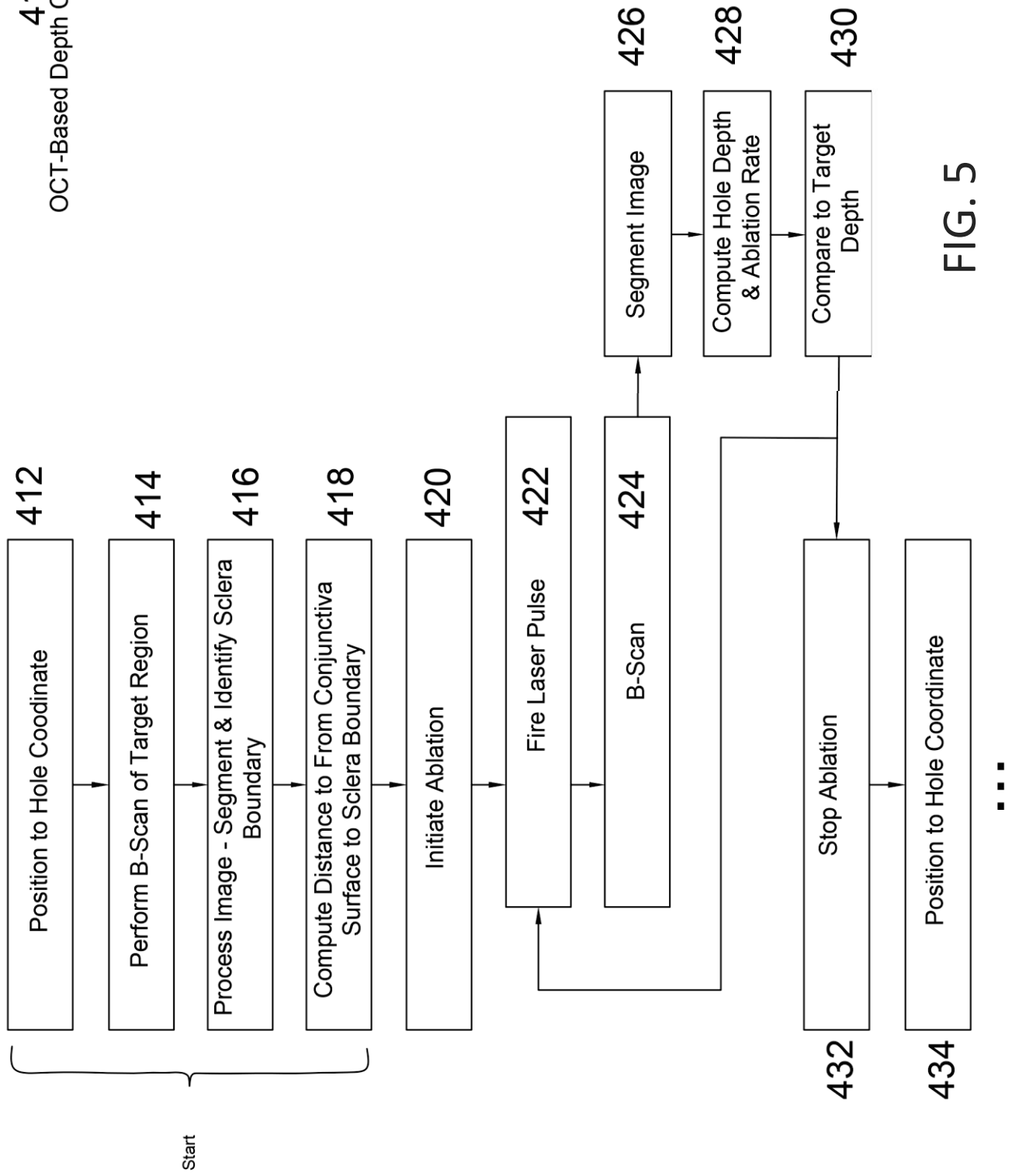


FIG. 4A-10



410
OCT-Based Depth Control Flow Diagram



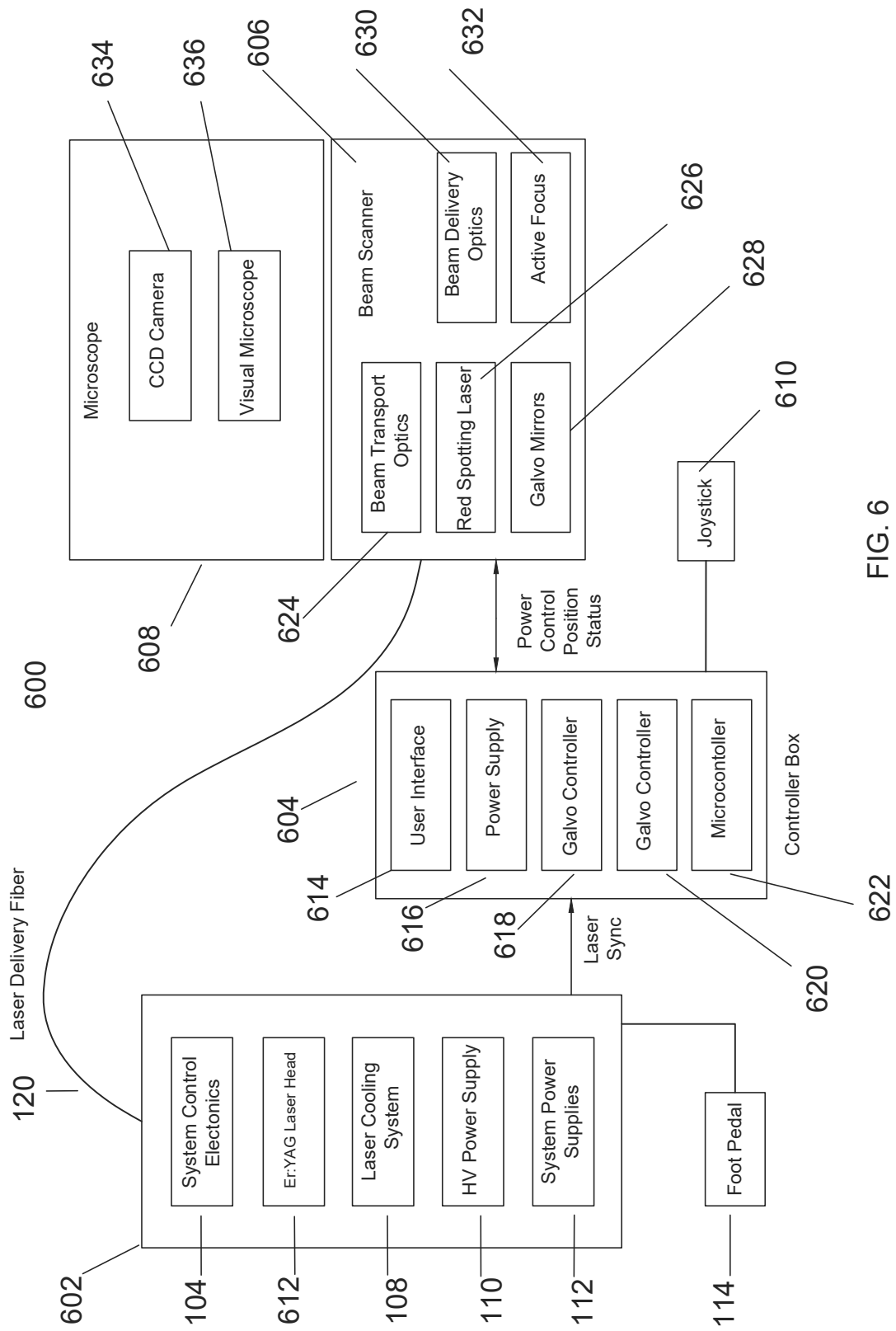


FIG. 6



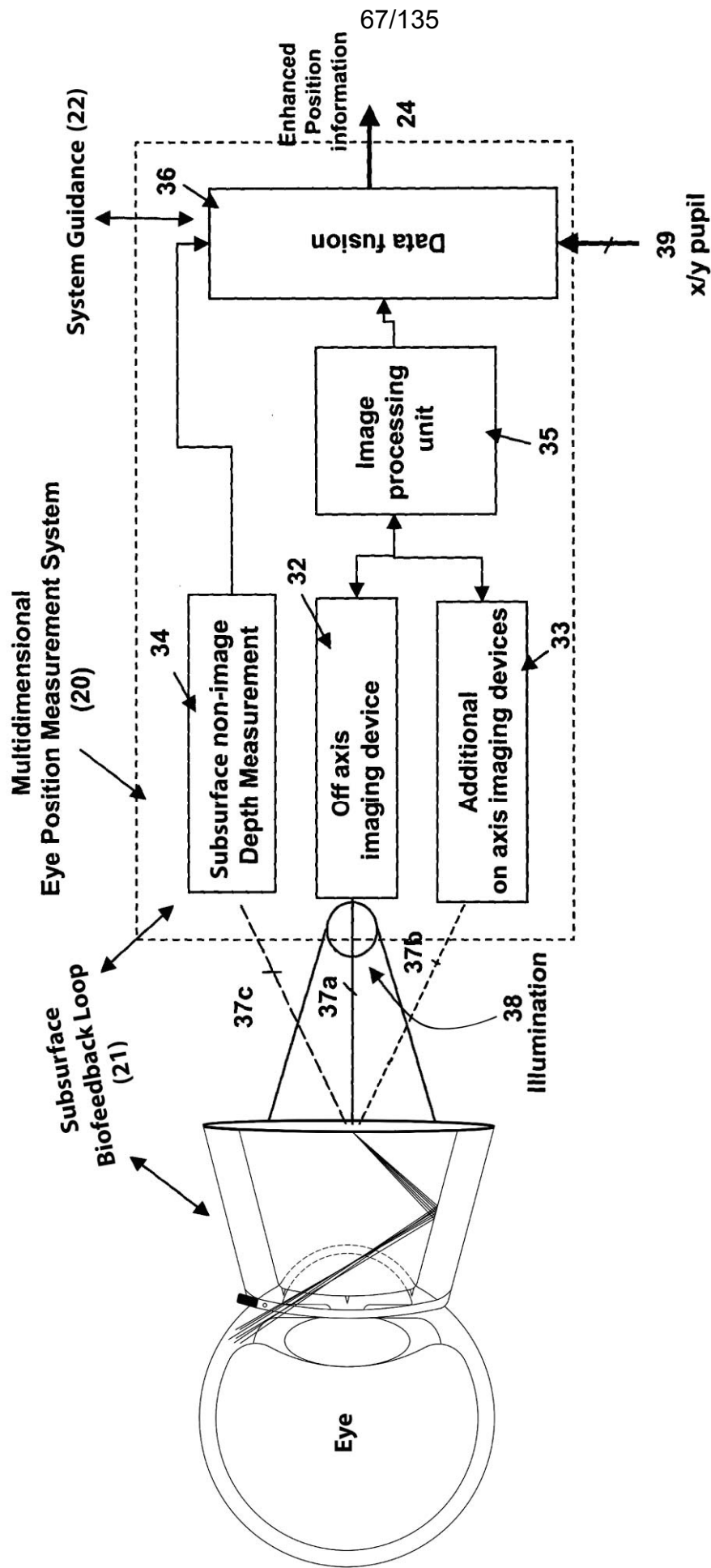


FIG. 7-1

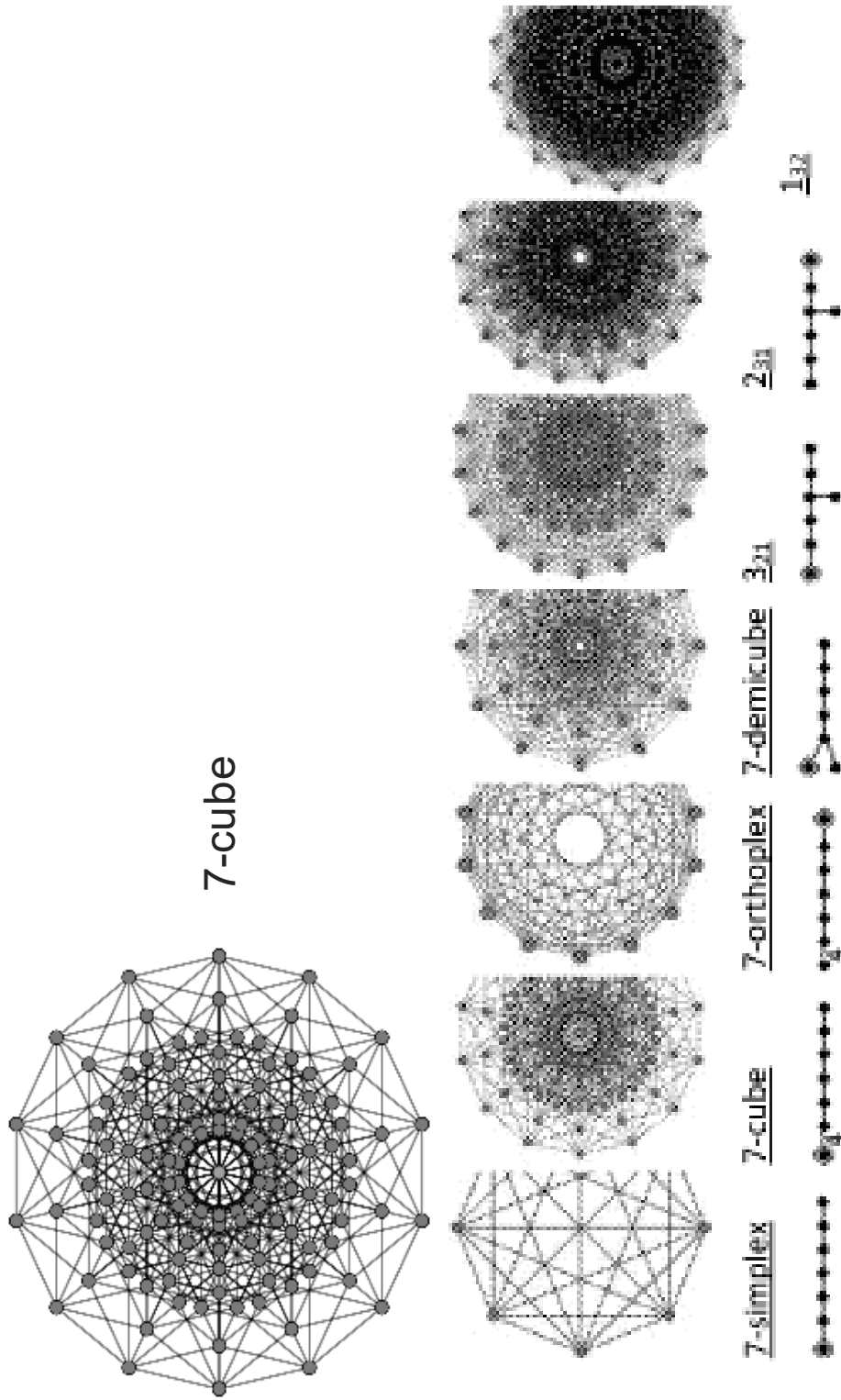


FIG. 8

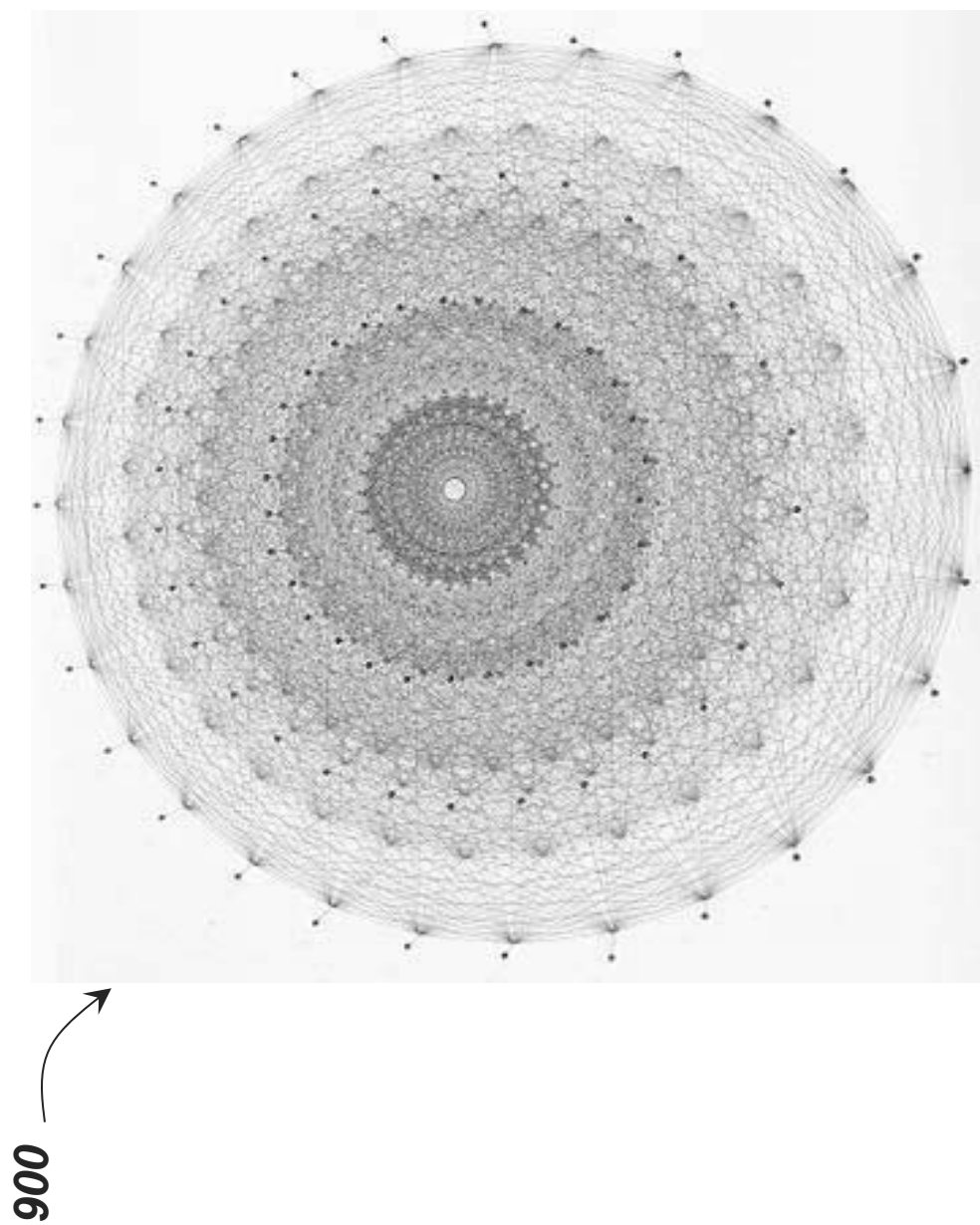
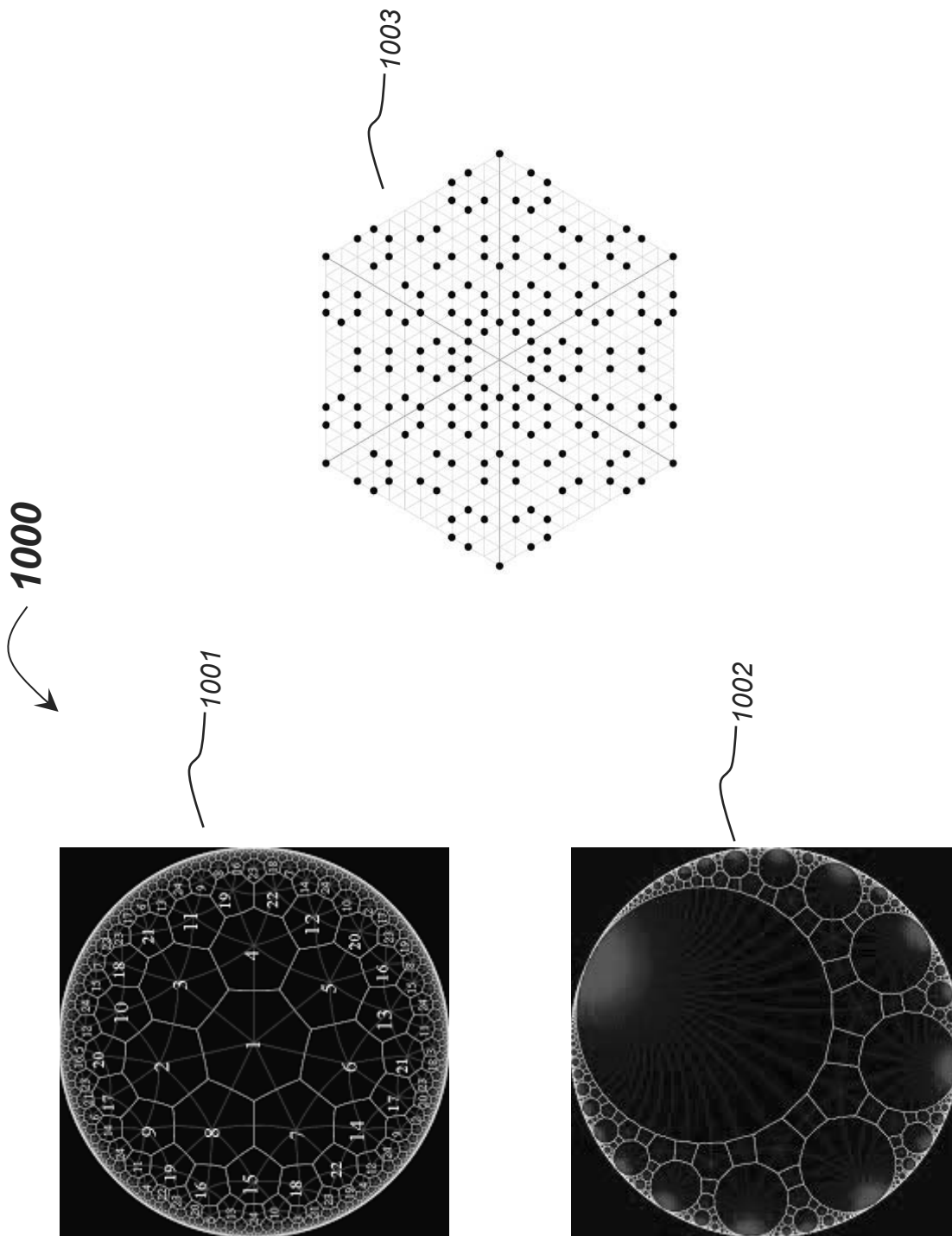


FIG. 9



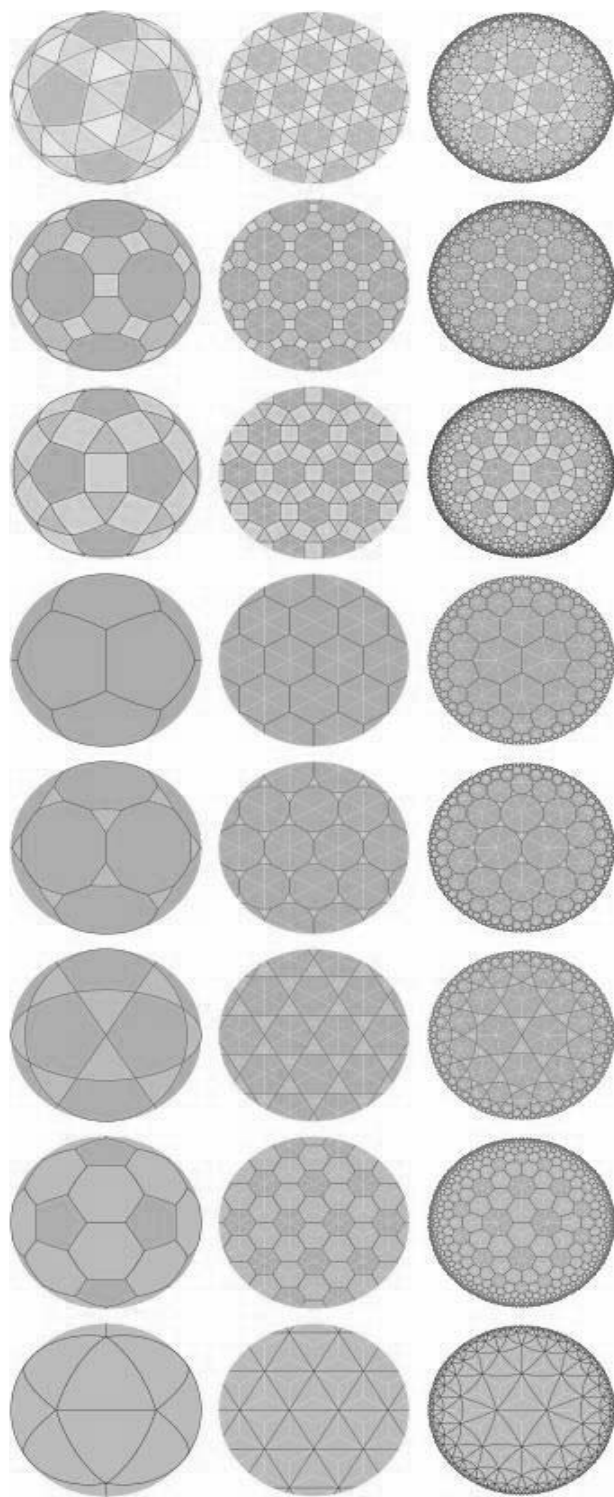


FIG. 11

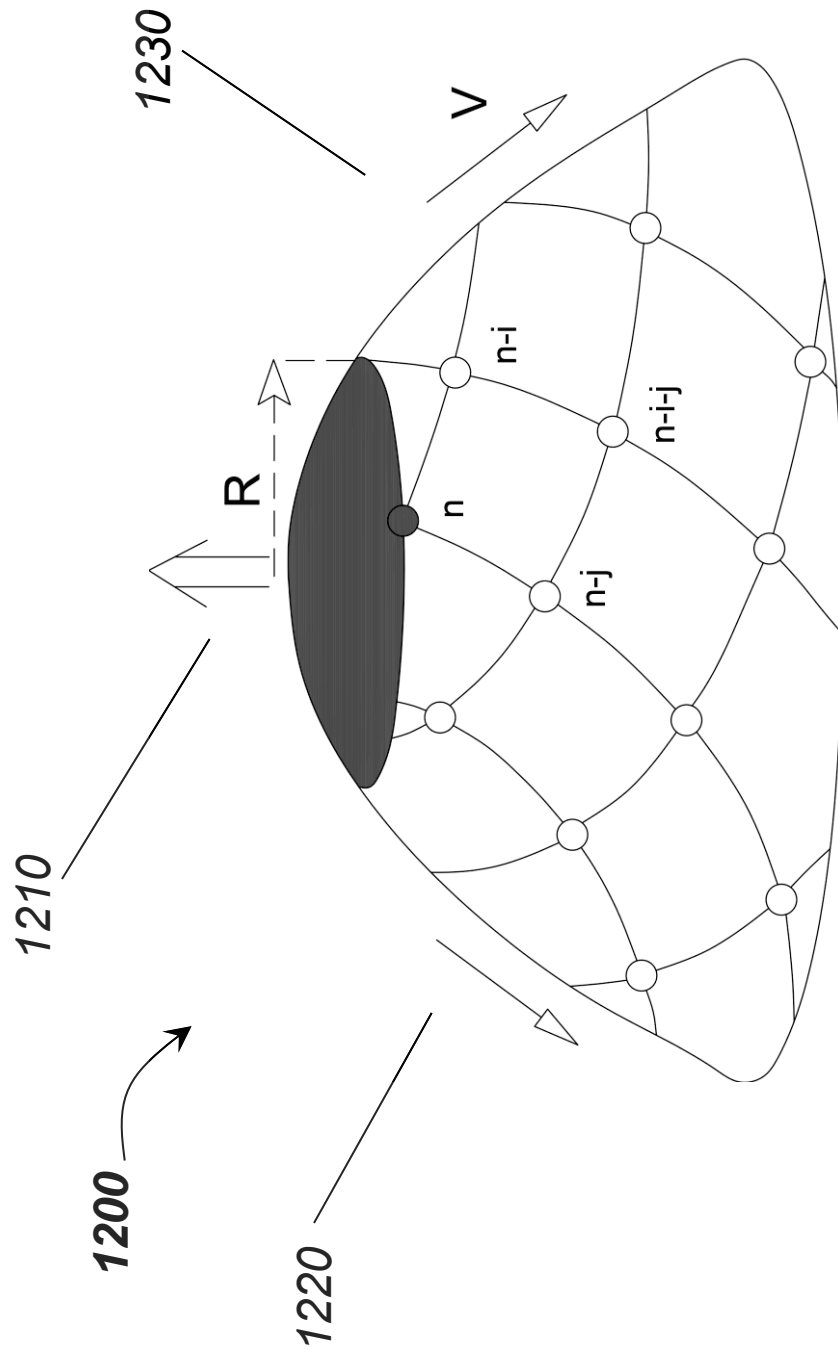
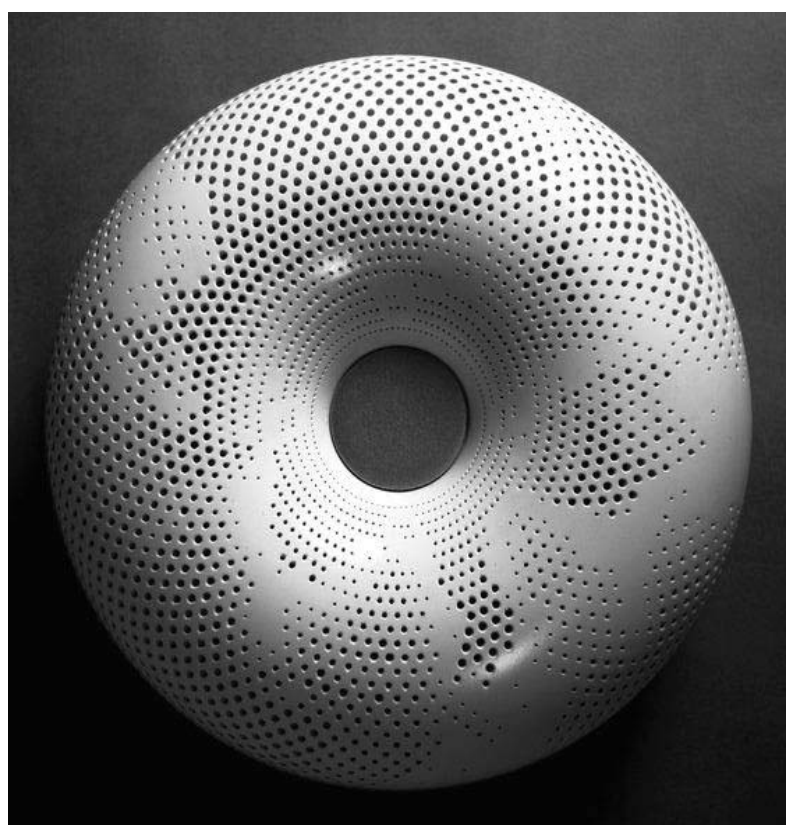


FIG. 12



1300

FIG. 13

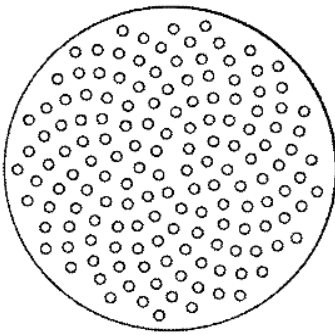


FIG. 14A

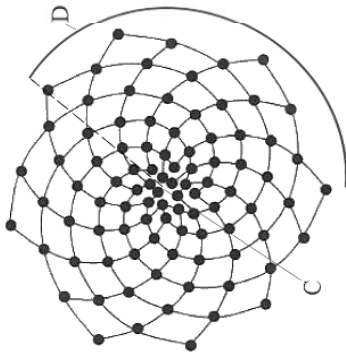


FIG. 14B

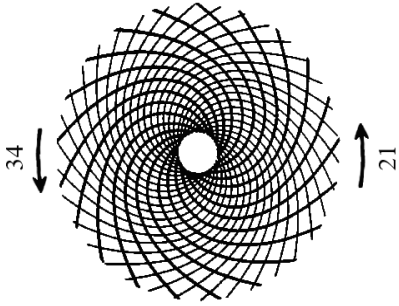


FIG. 14C

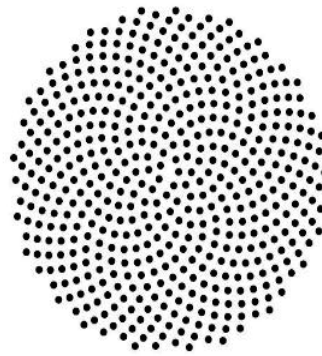


FIG. 14D

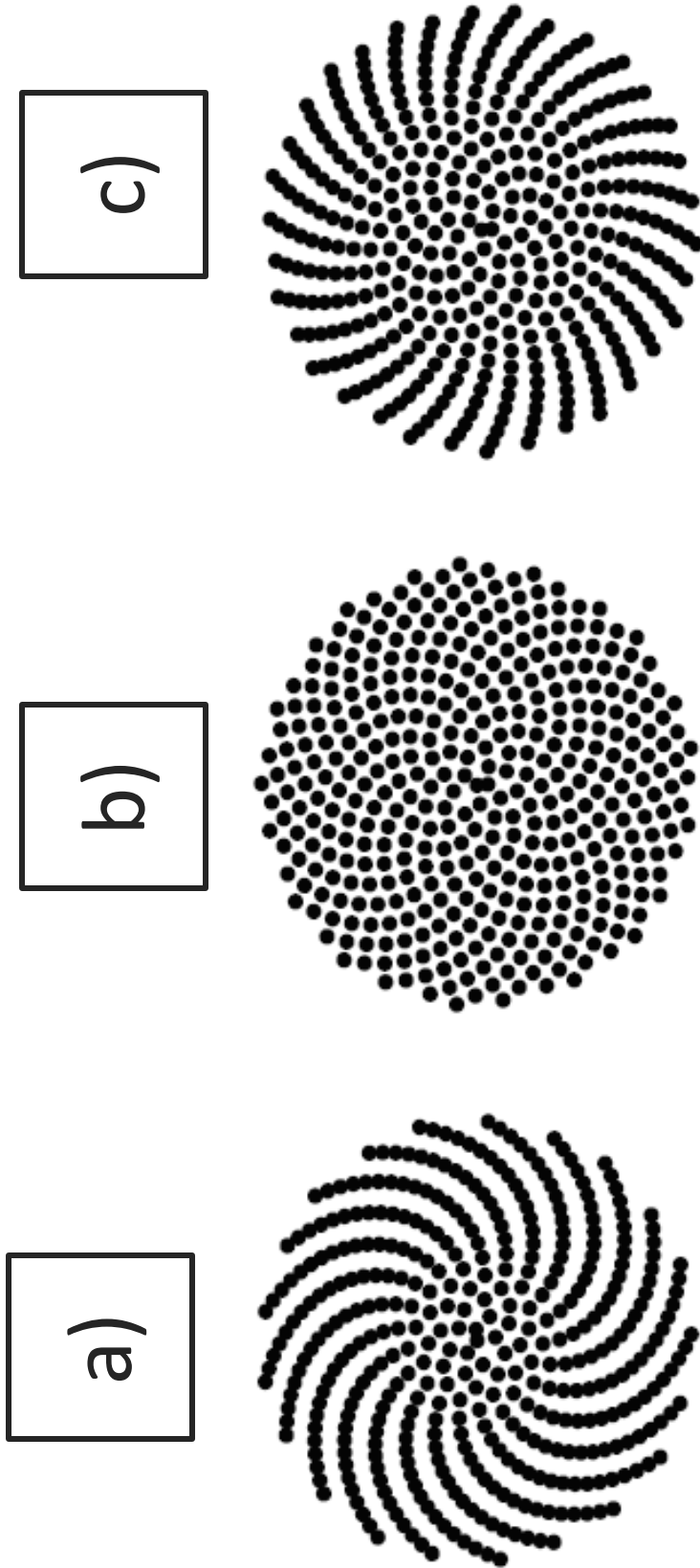
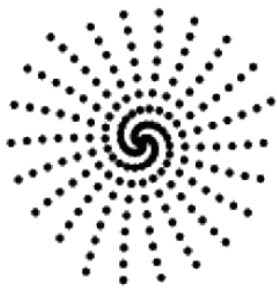
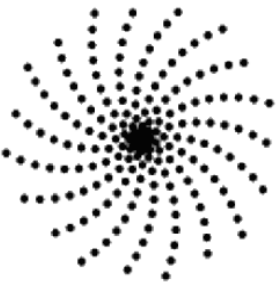


FIG. 14E



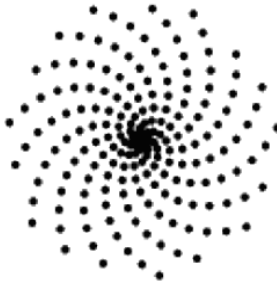
$$\alpha = \frac{1}{\pi}$$

FIG. 15A



$$\alpha = \frac{1}{e}$$

FIG. 15B



$$\alpha = \frac{1}{\sqrt{2}}$$

FIG. 15C

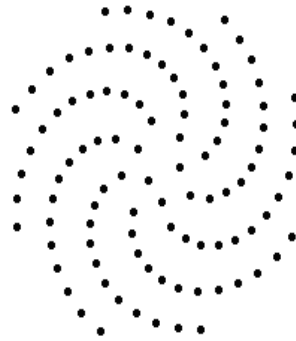


FIG. 15D

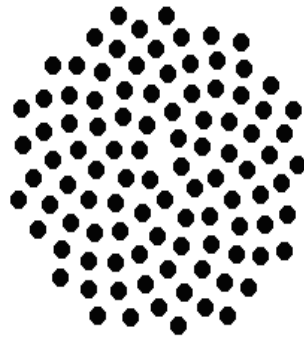


FIG. 15E

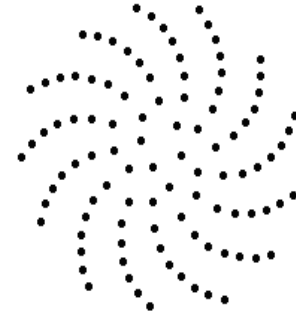


FIG. 15F

FIG. 16A



FIG. 16B



FIG. 16C

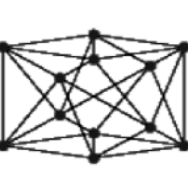


FIG. 16D

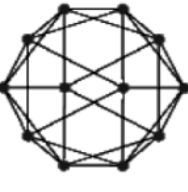


FIG. 16E

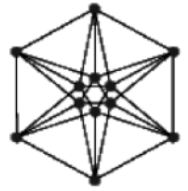


FIG. 16F

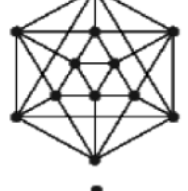


FIG. 16G

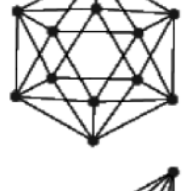


FIG. 16H



FIG. 16I

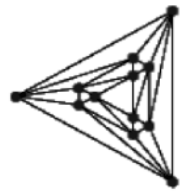


FIG. 16J



FIG. 16K

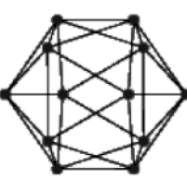


FIG. 16L

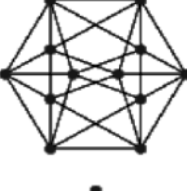


FIG. 16M

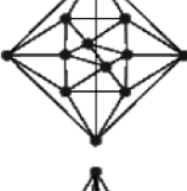


FIG. 16N



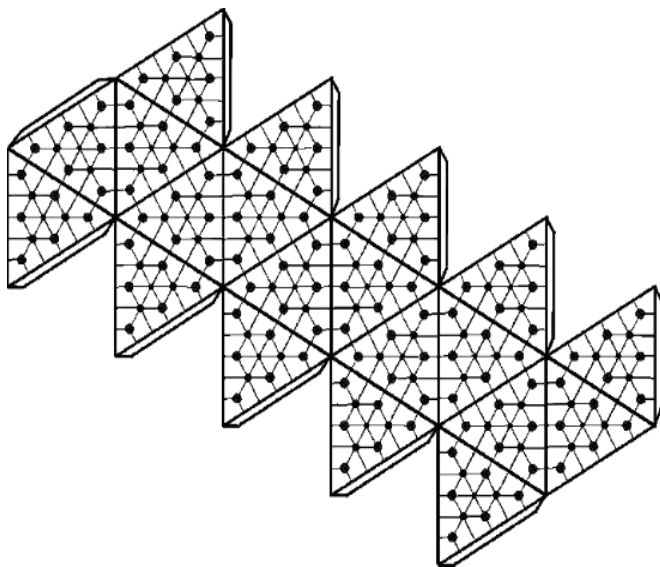


FIG. 17A

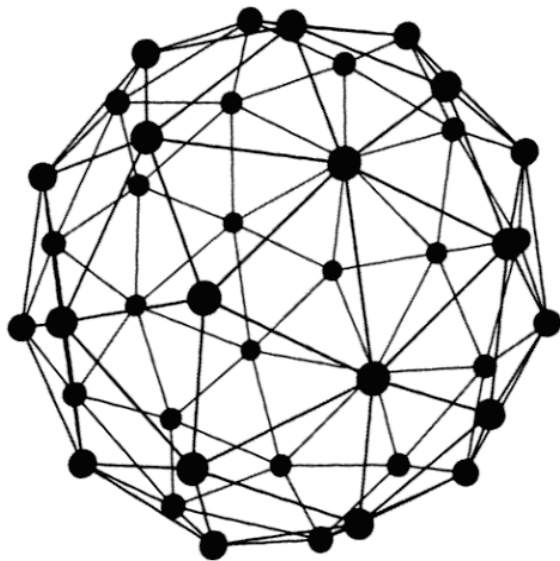


FIG. 17B

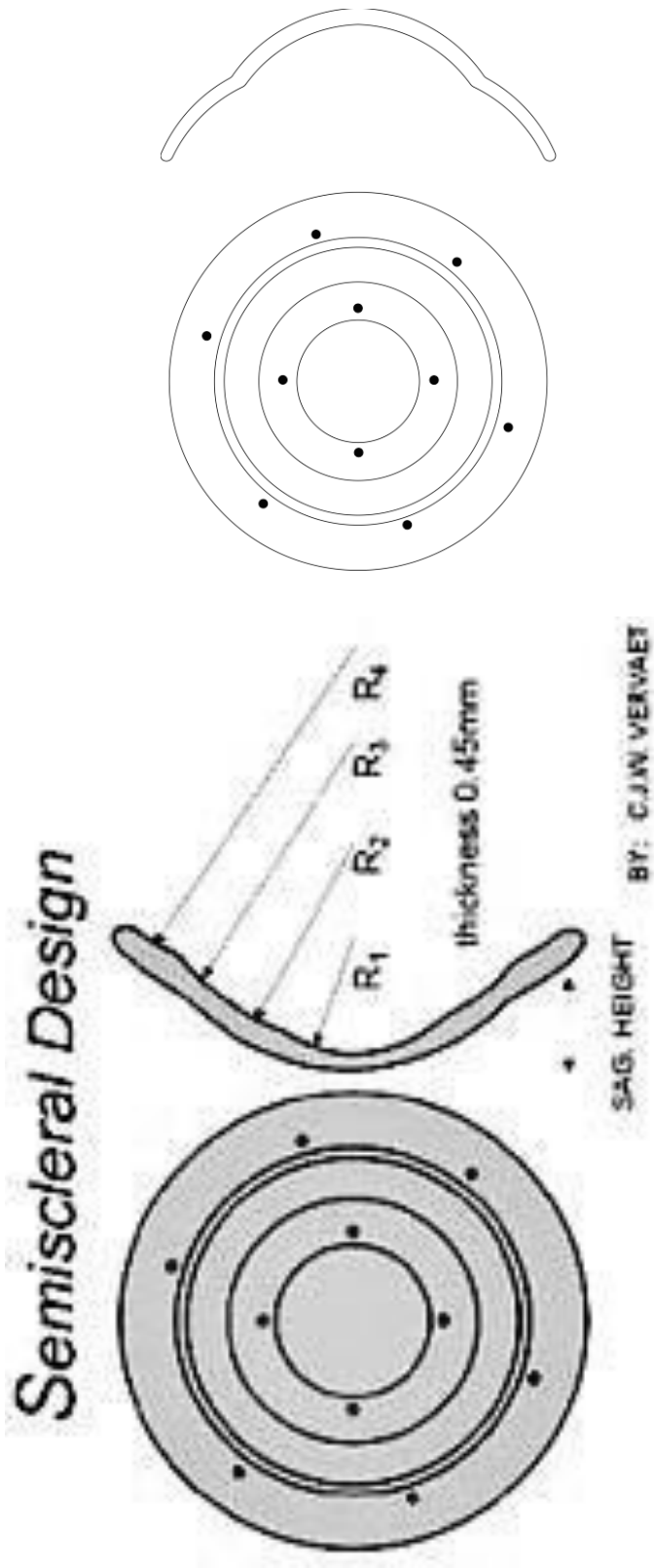


FIG. 18

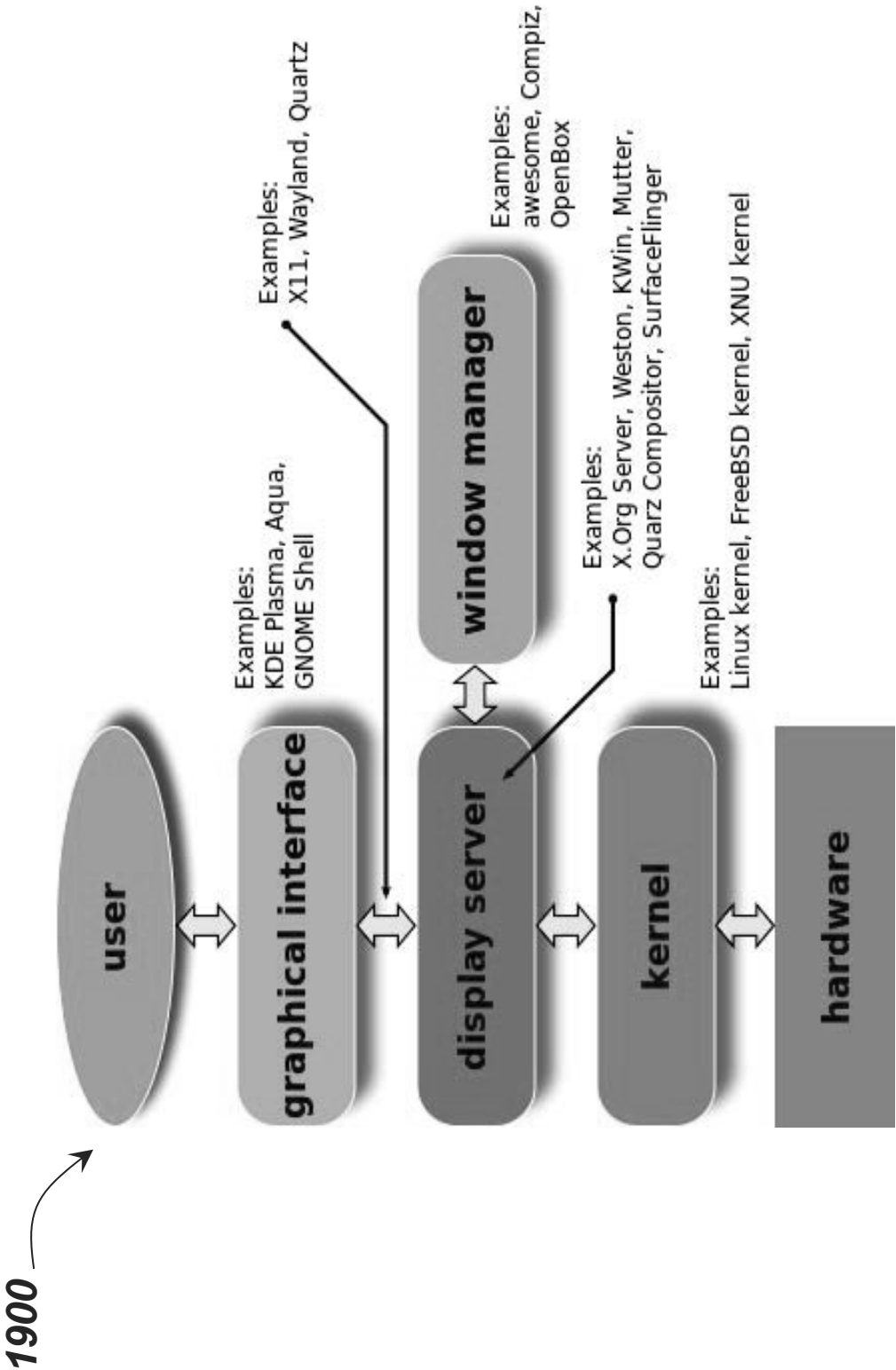


FIG. 19

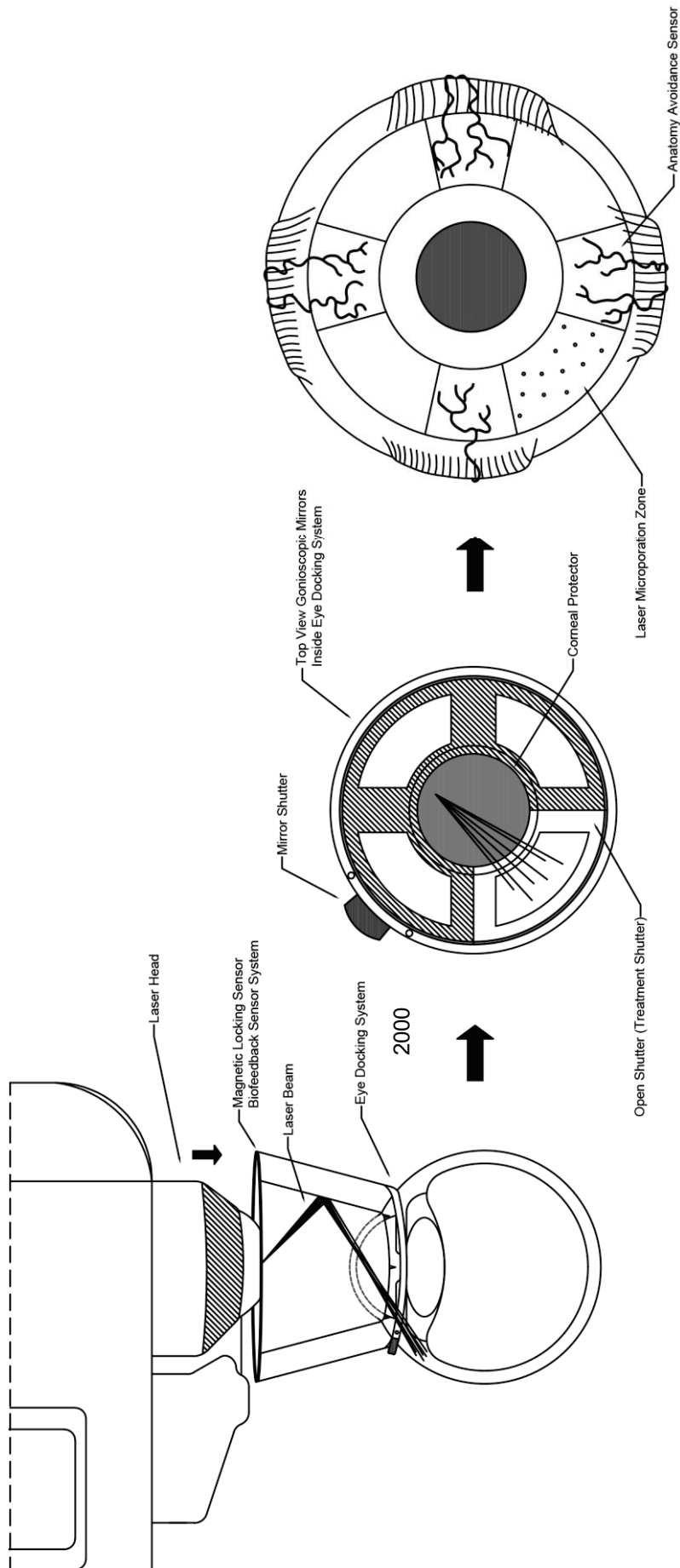


FIG. 20

Eye docking station with gonio mirrors
for galvos scan delivery

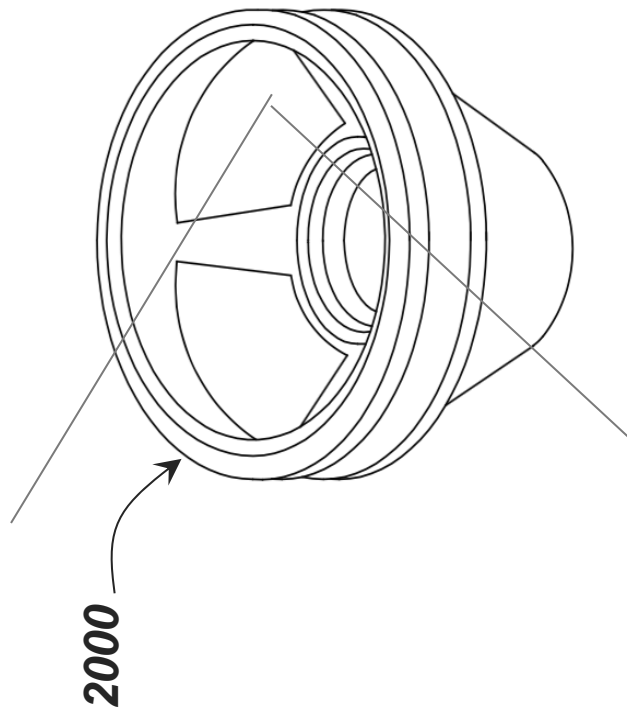


FIG. 20A

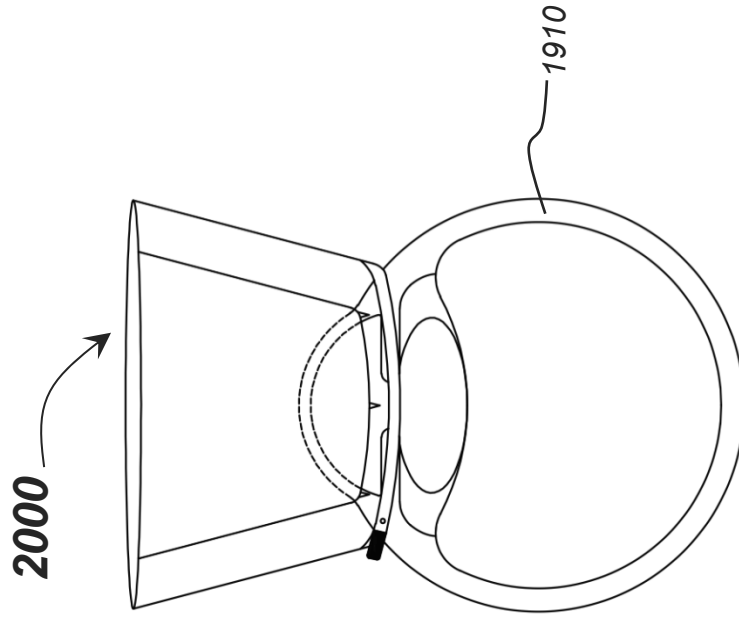


FIG. 20B

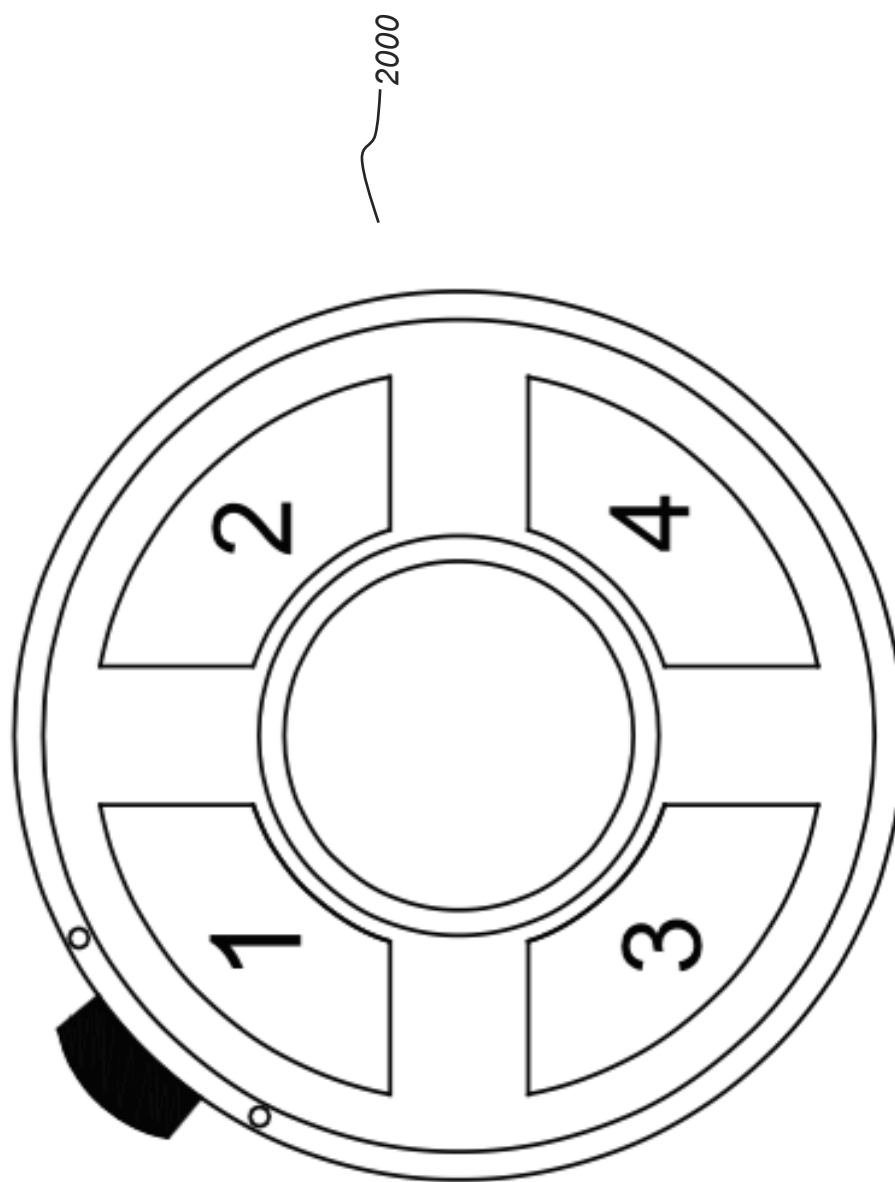


FIG. 20C

Scleral fixation component

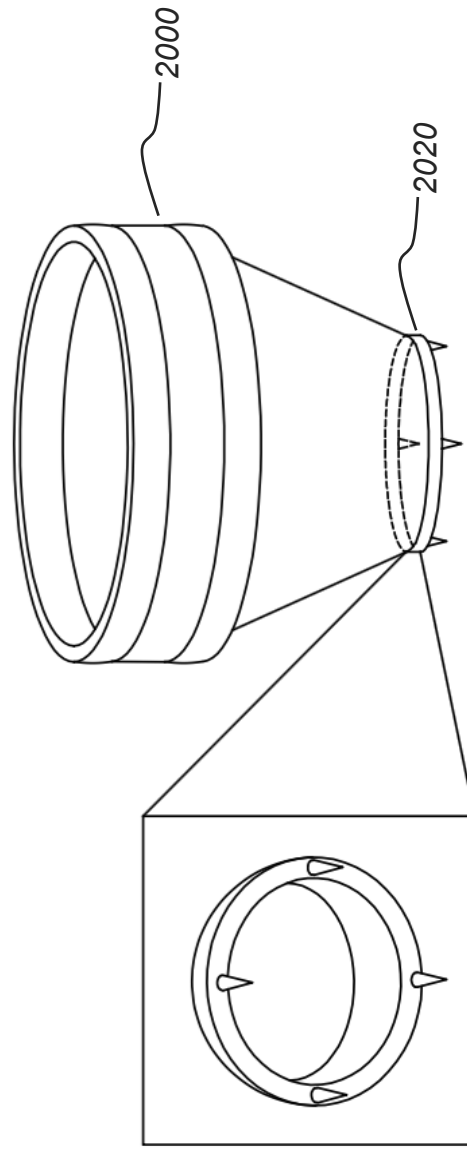


FIG. 20D

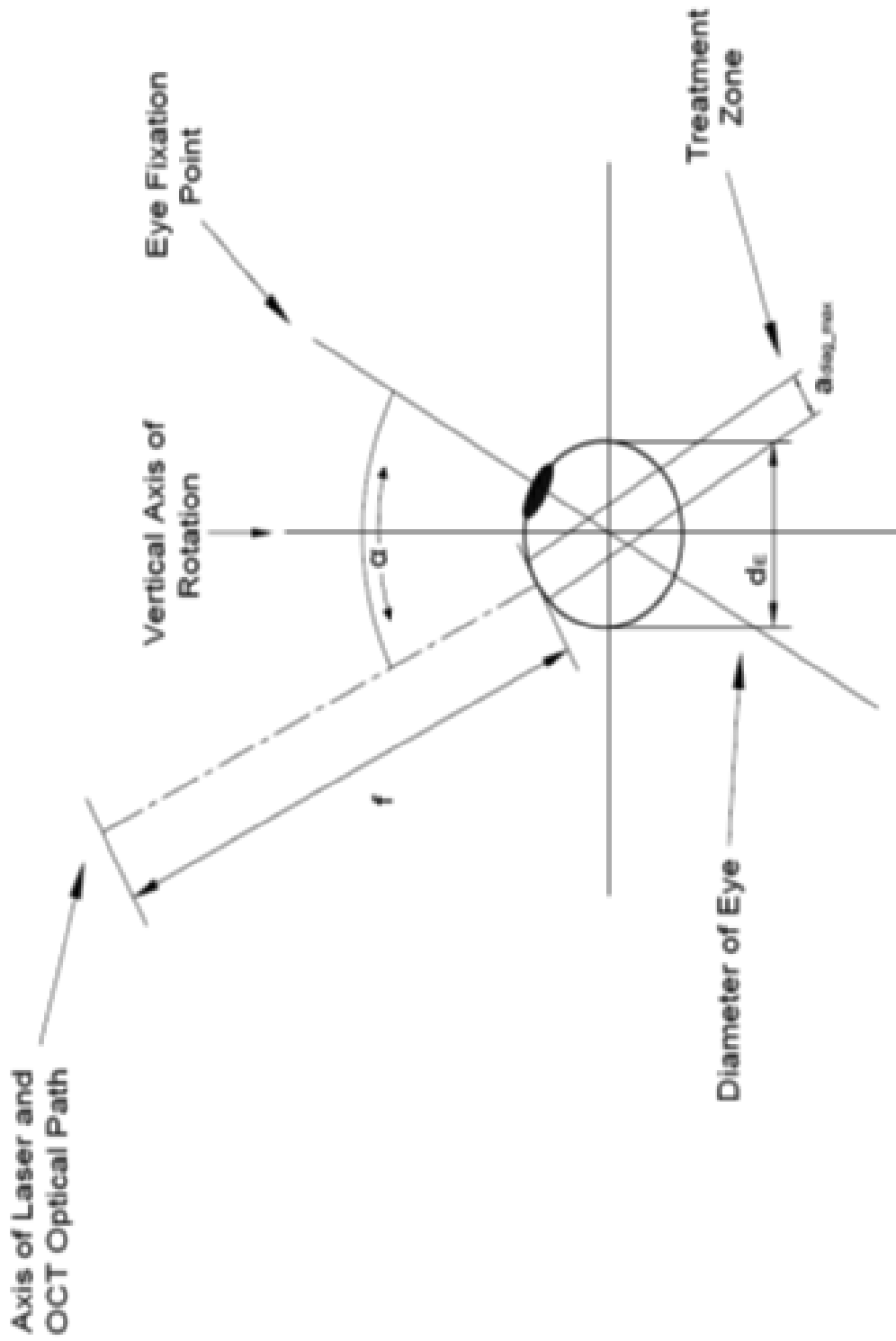


FIG. 20E

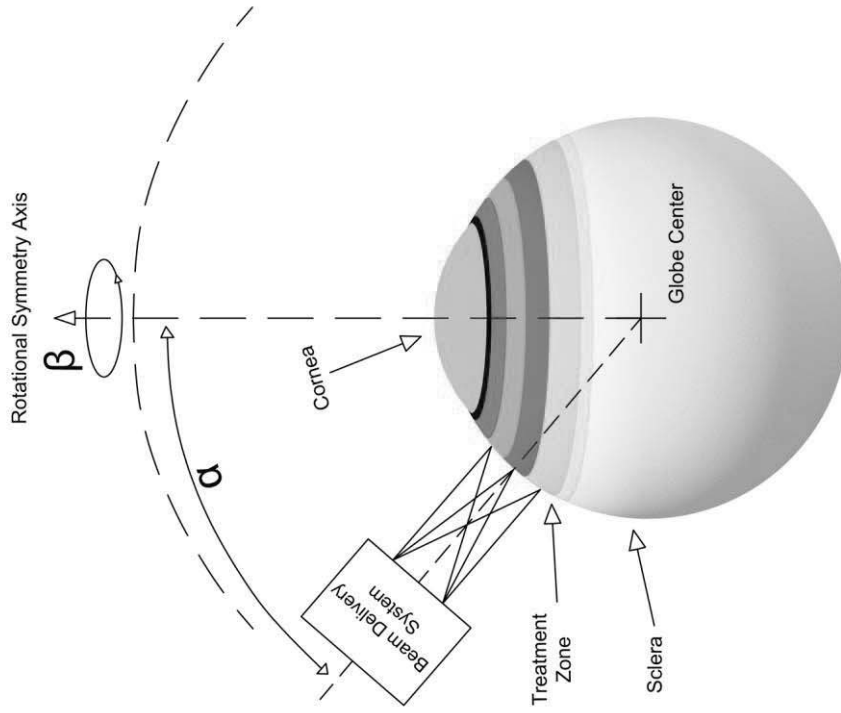


FIG. 20F

(#1) Laser Beam w/ Mirror Galvo
Positioning

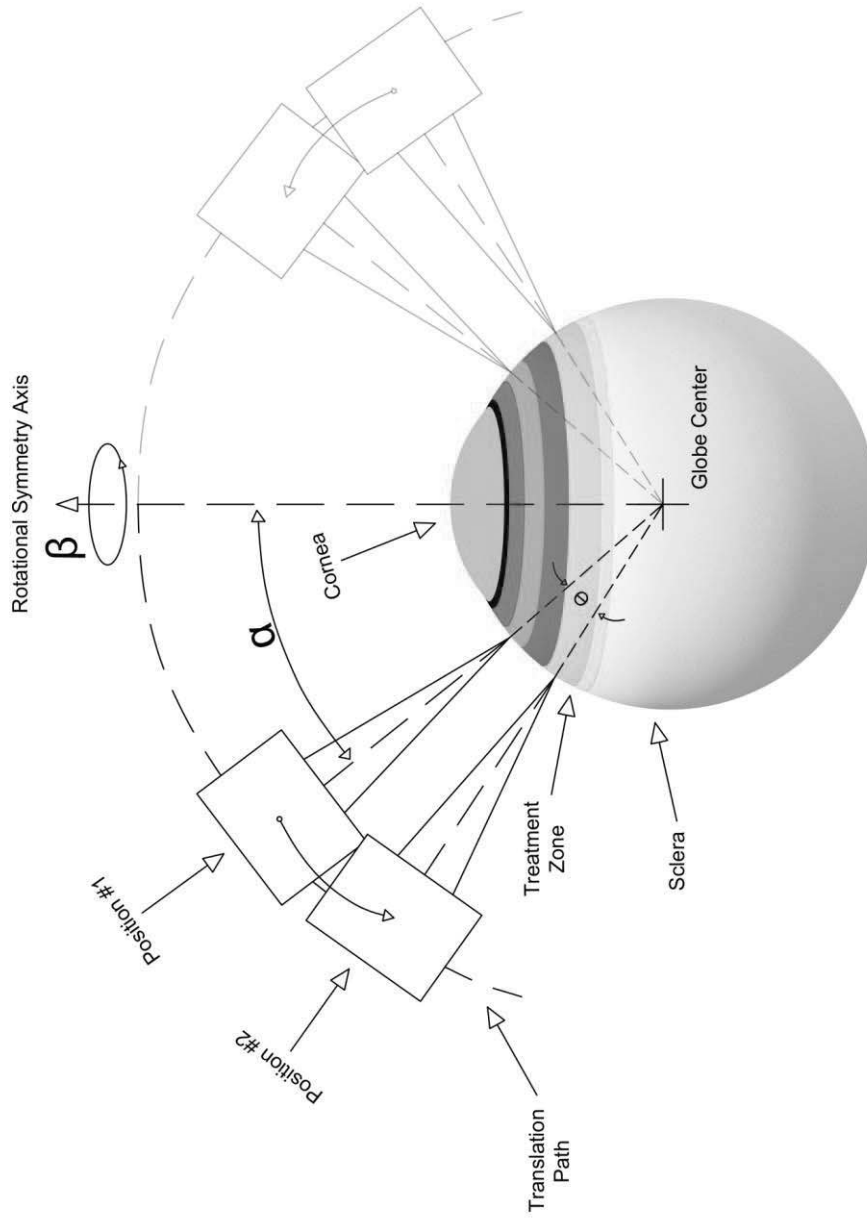


FIG. 20G

(#2) Entire Laser Head C/L Moves,
NO Mirrors

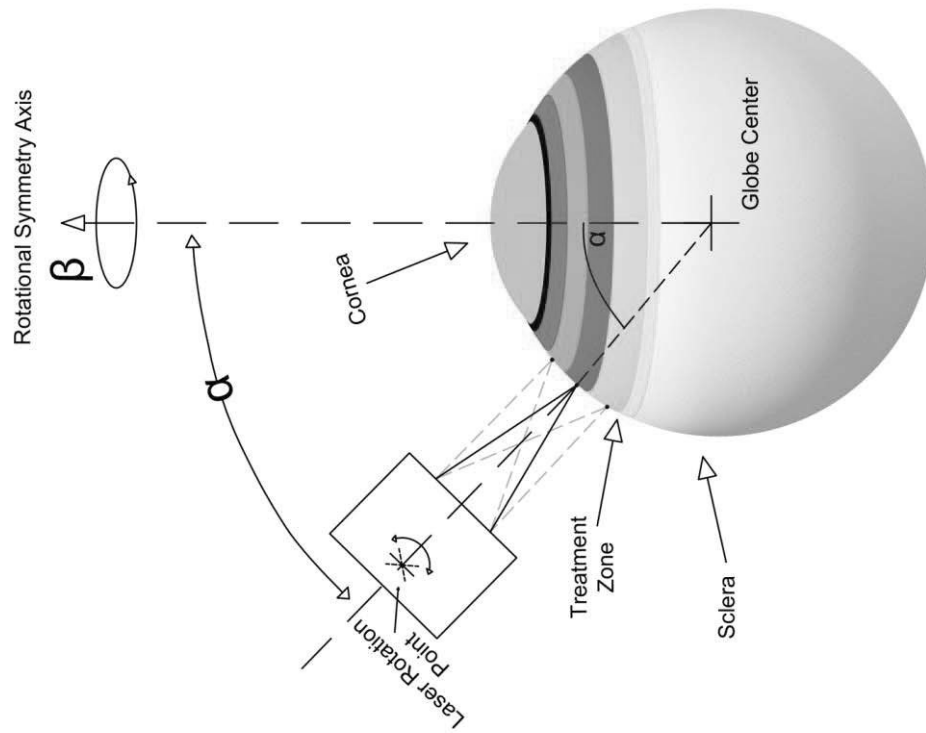


FIG. 20H

(#3) Laser Rotates To Aim Beam
Position On Eye, NO Mirrors

Off Axis Scanning: Treatment is Angular

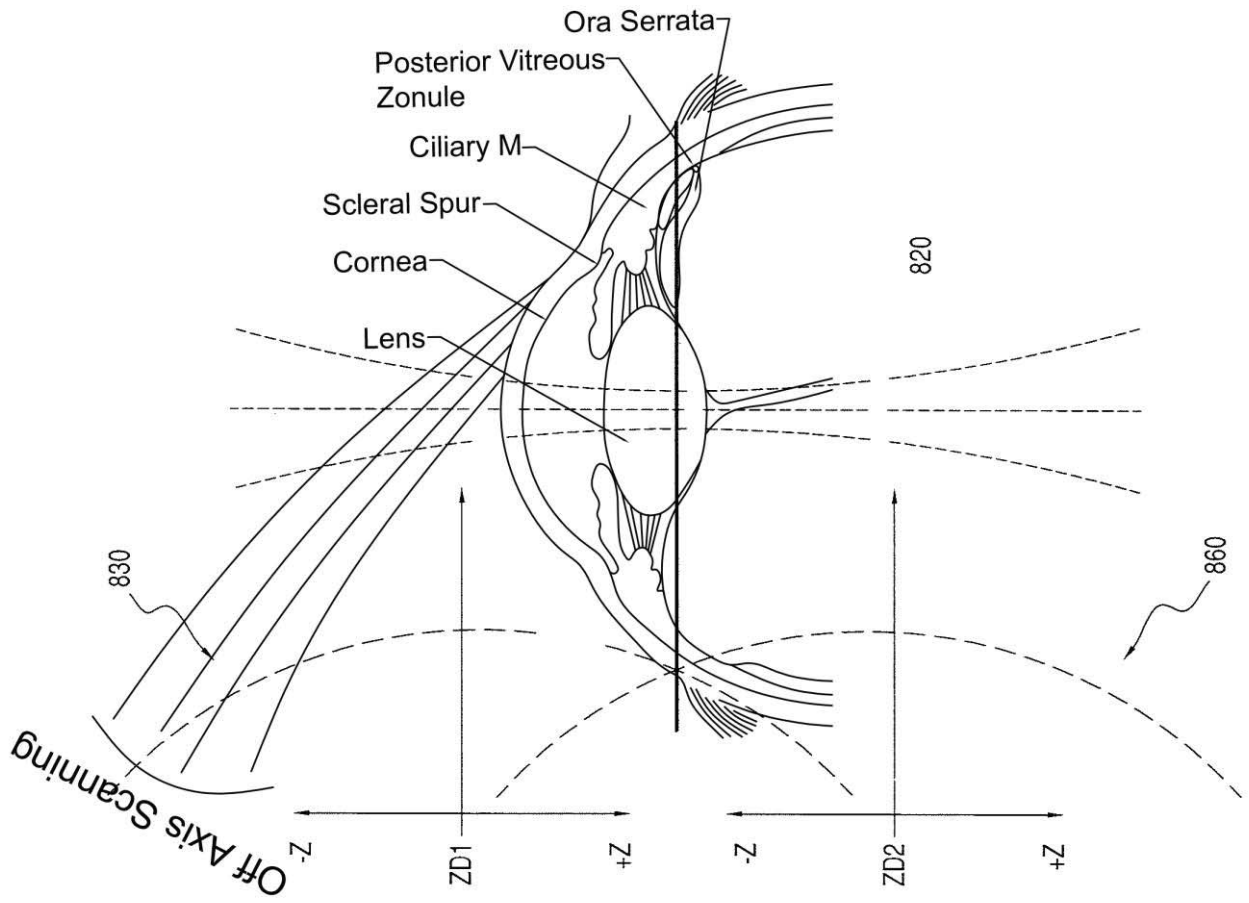


FIG. 20I

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

Center rotation axis fix Treatment position 20°

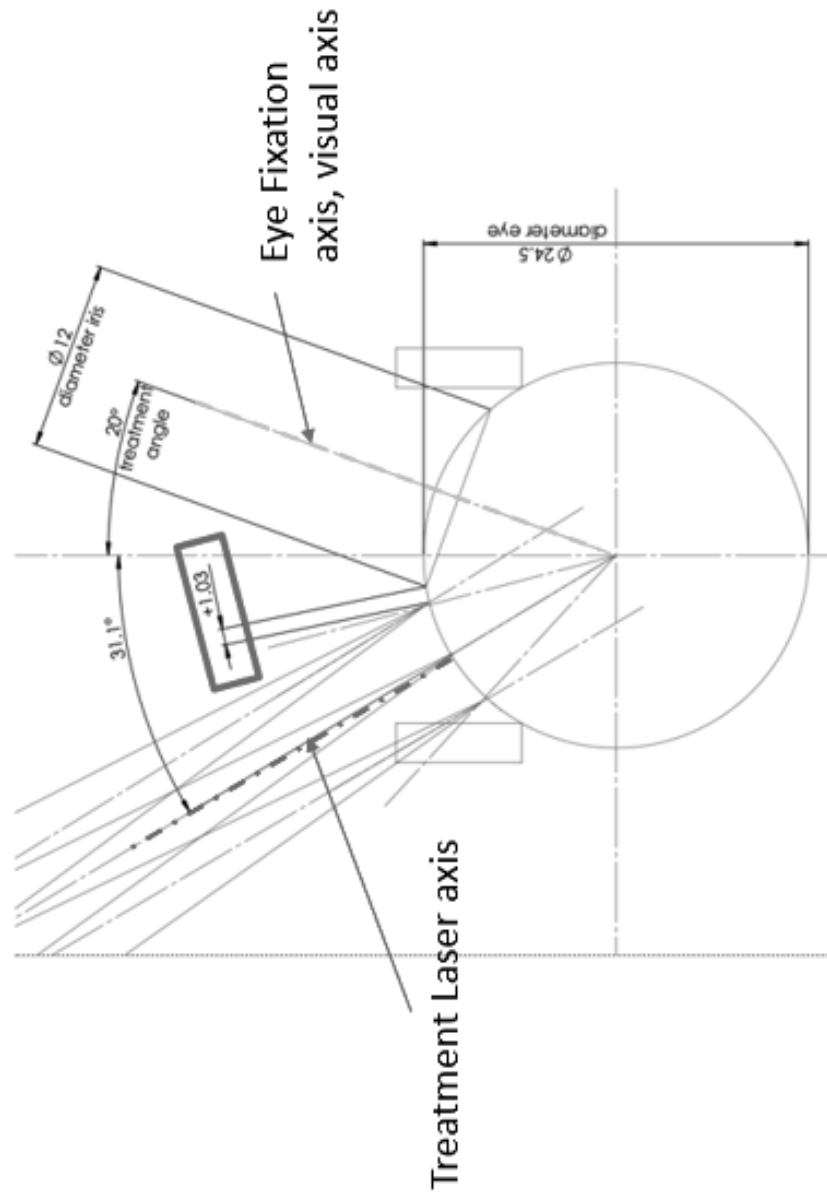


FIG. 20I-1

Extreme eye movements : Off Axis Scanning laser beam NOT coincident with the visual axis or the pupil

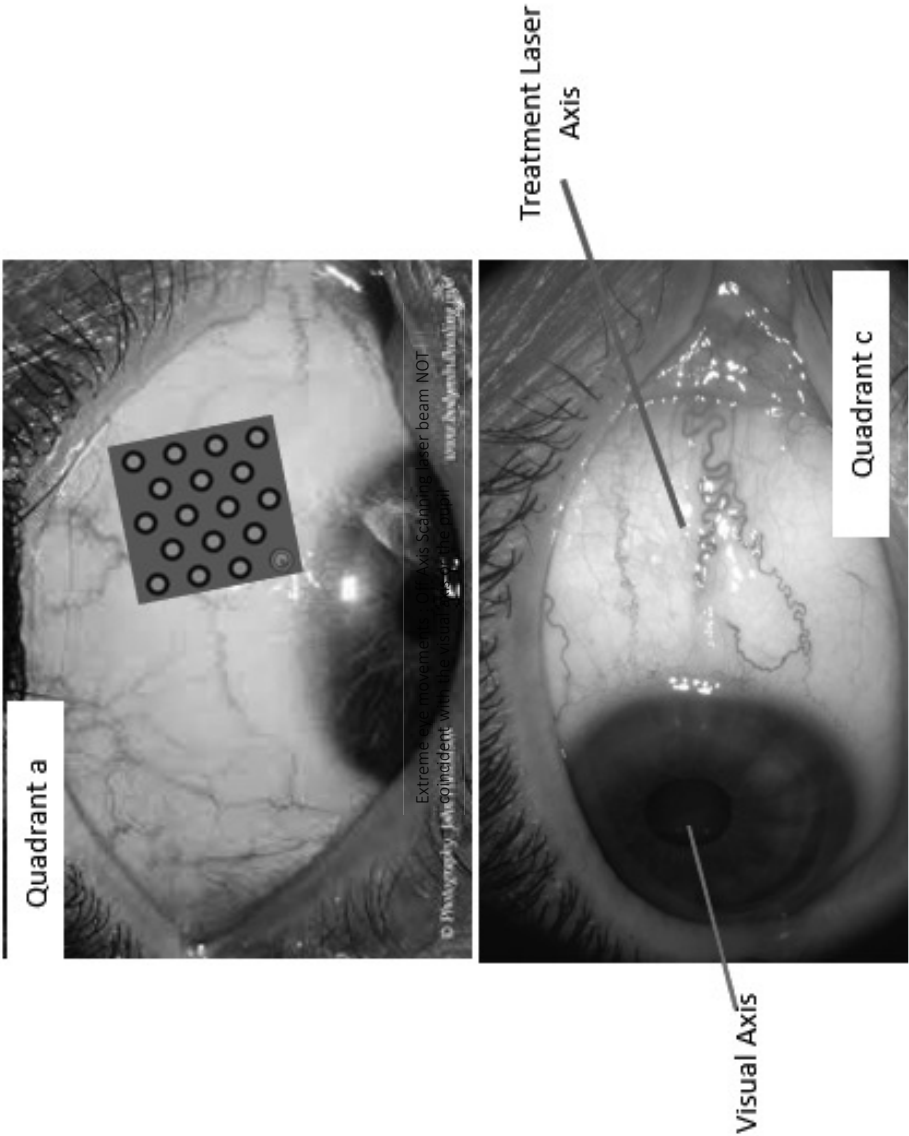


FIG. 20I-2

Extreme eye movements : Off Axis Scanning laser beam NOT coincident with the visual axis or the pupil

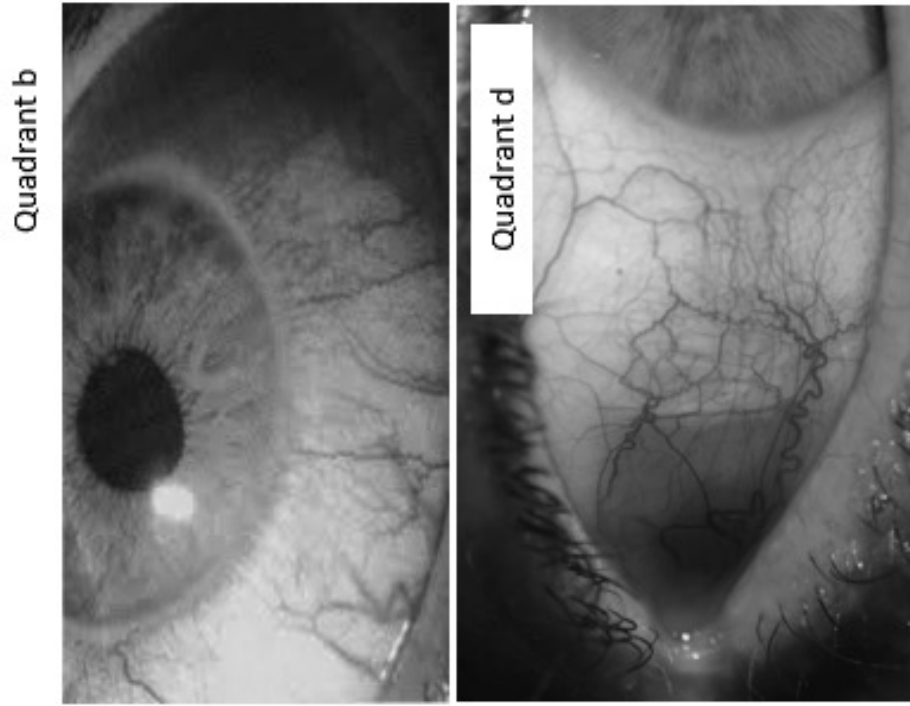


FIG. 20I-3

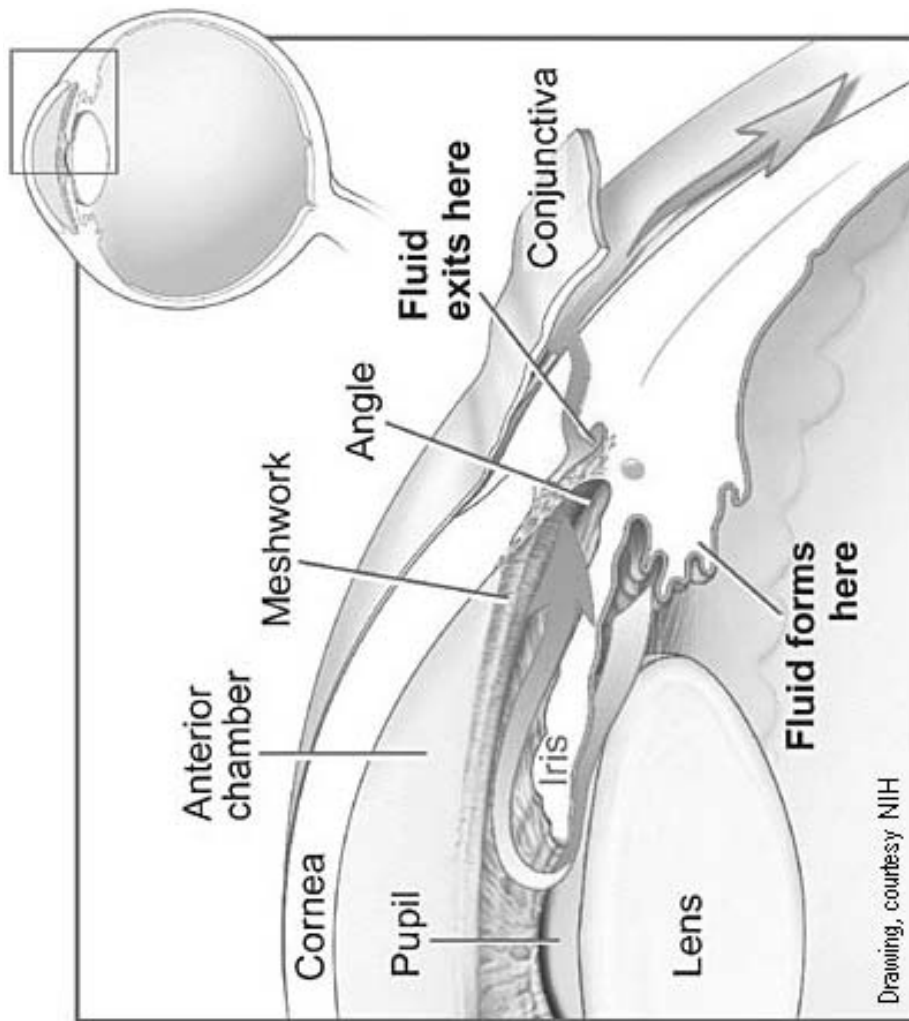


FIG. 20J

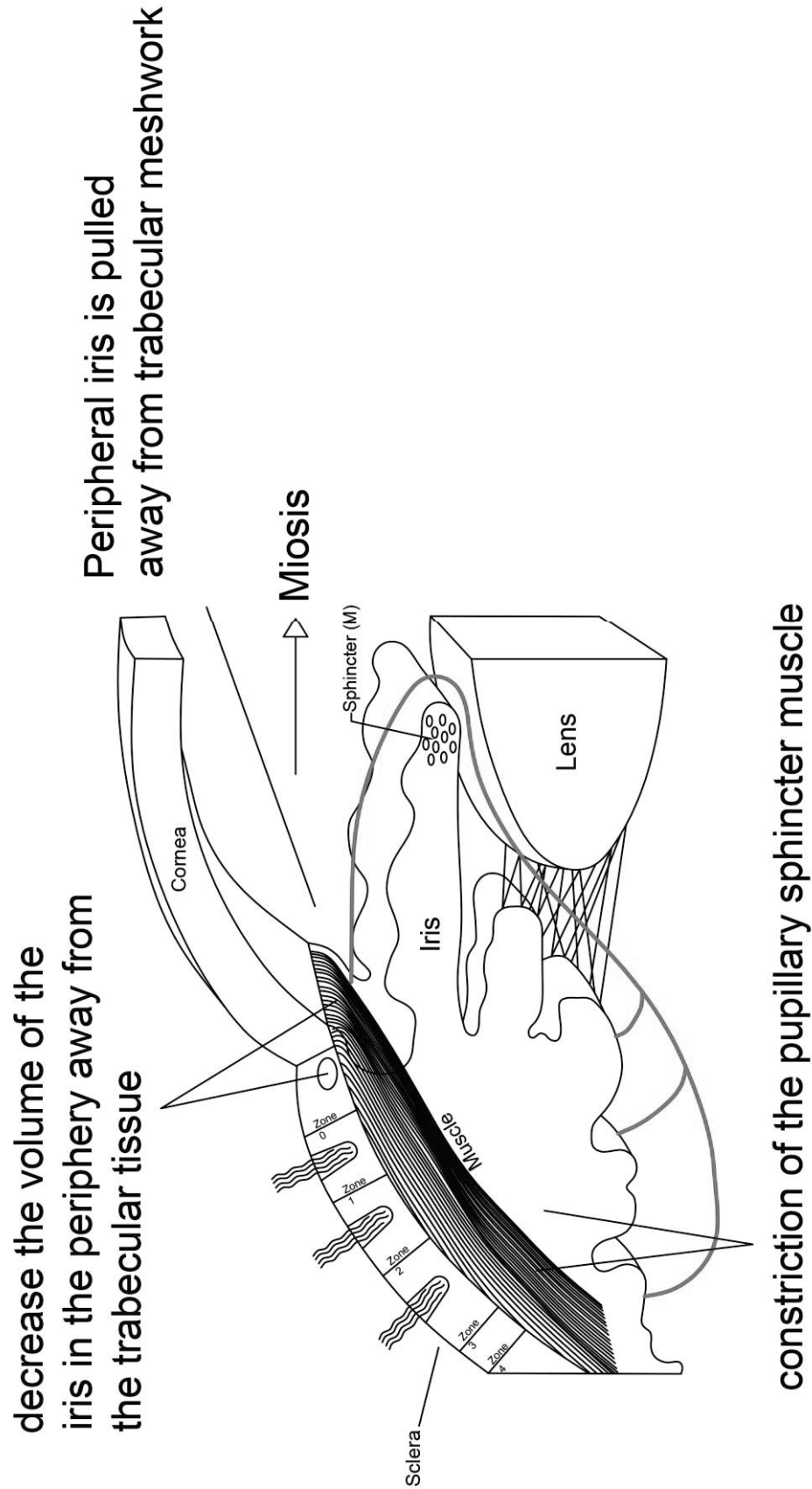


FIG. 20K

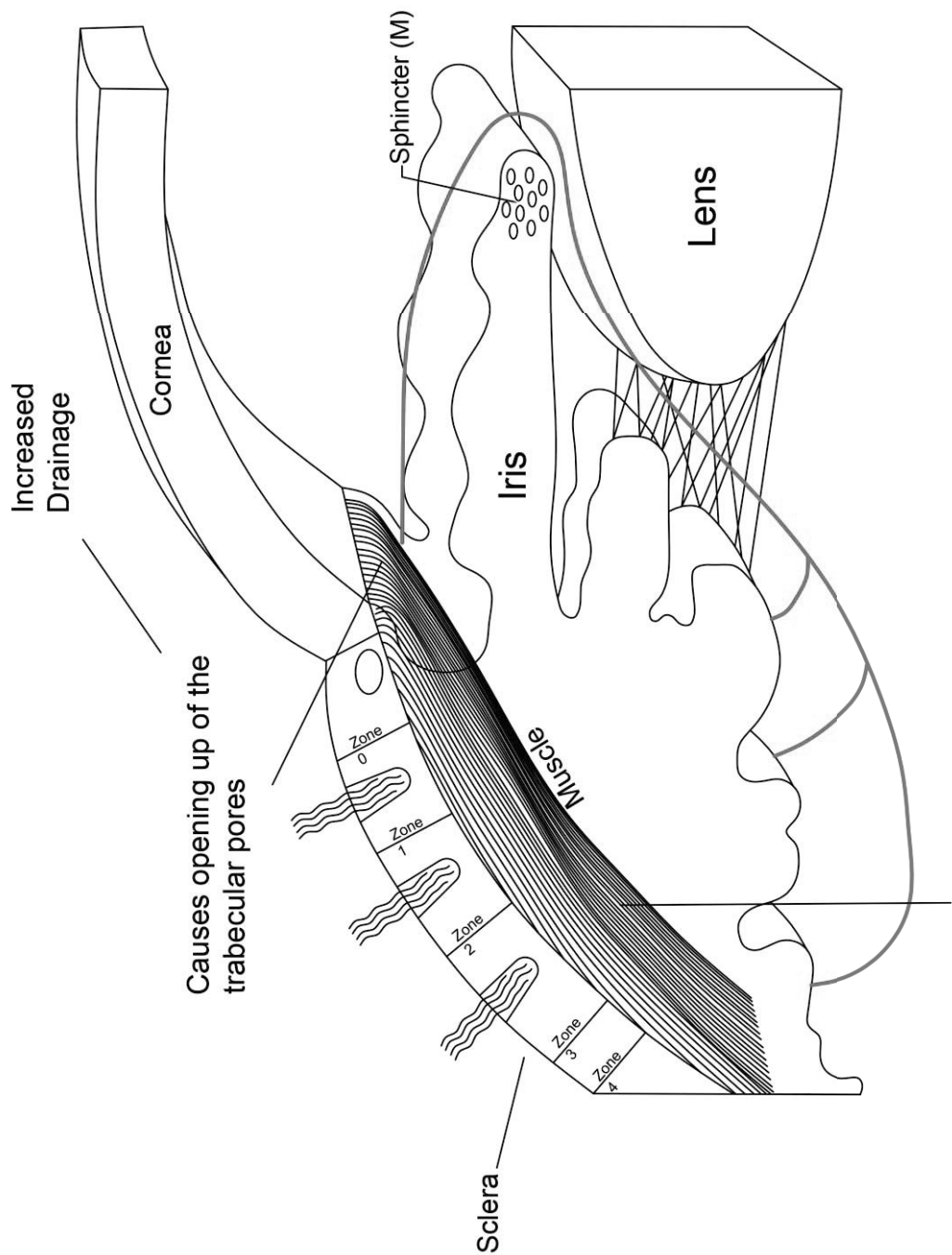


FIG. 20L

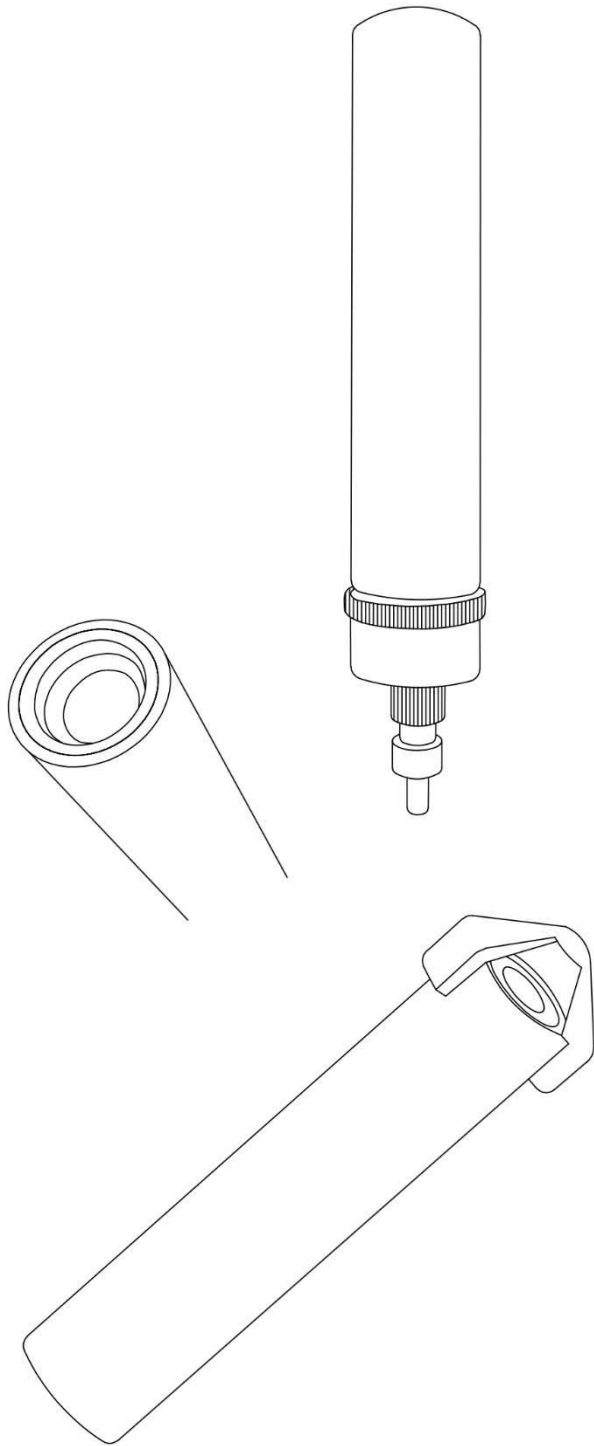


FIG. 20M

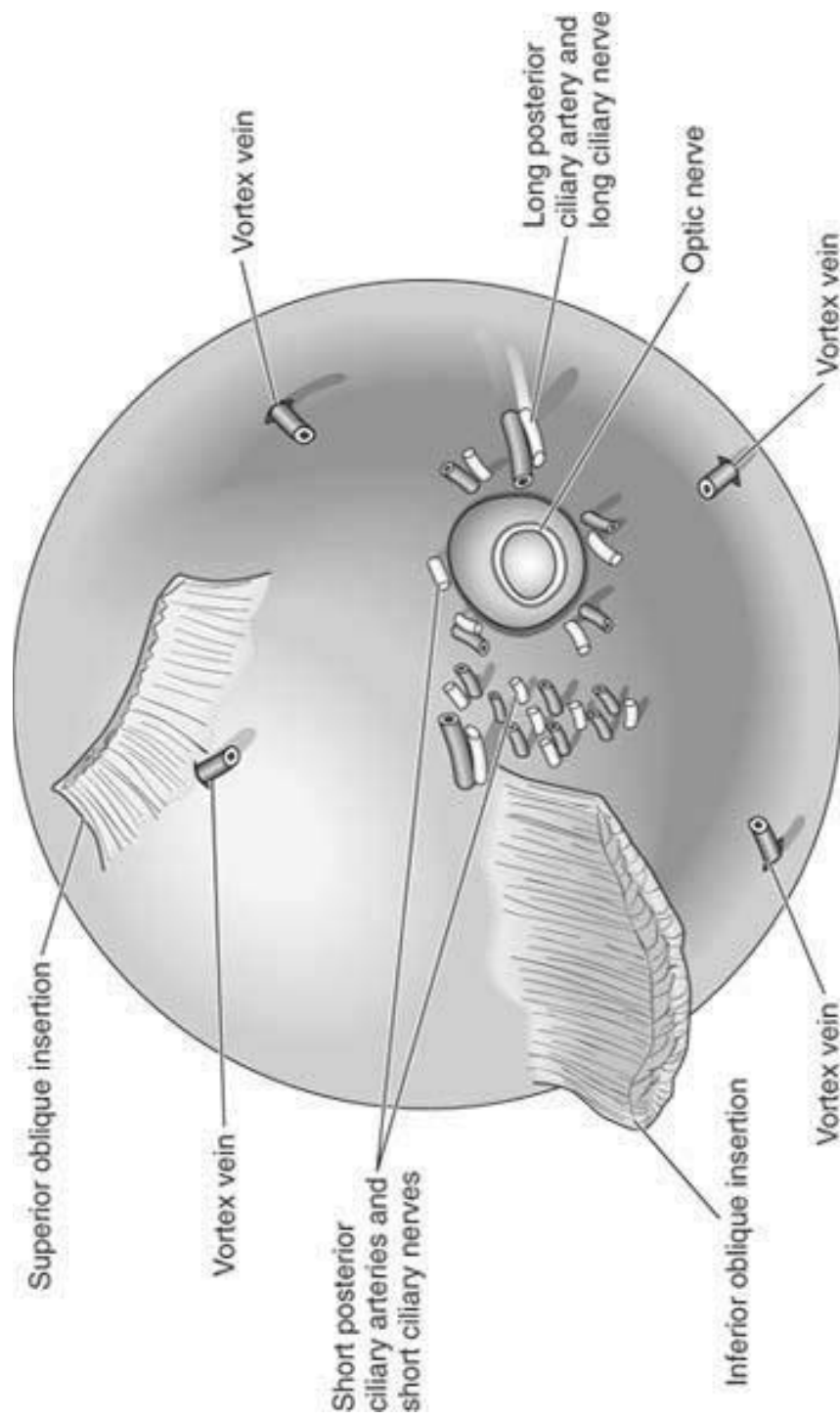


FIG. 20N

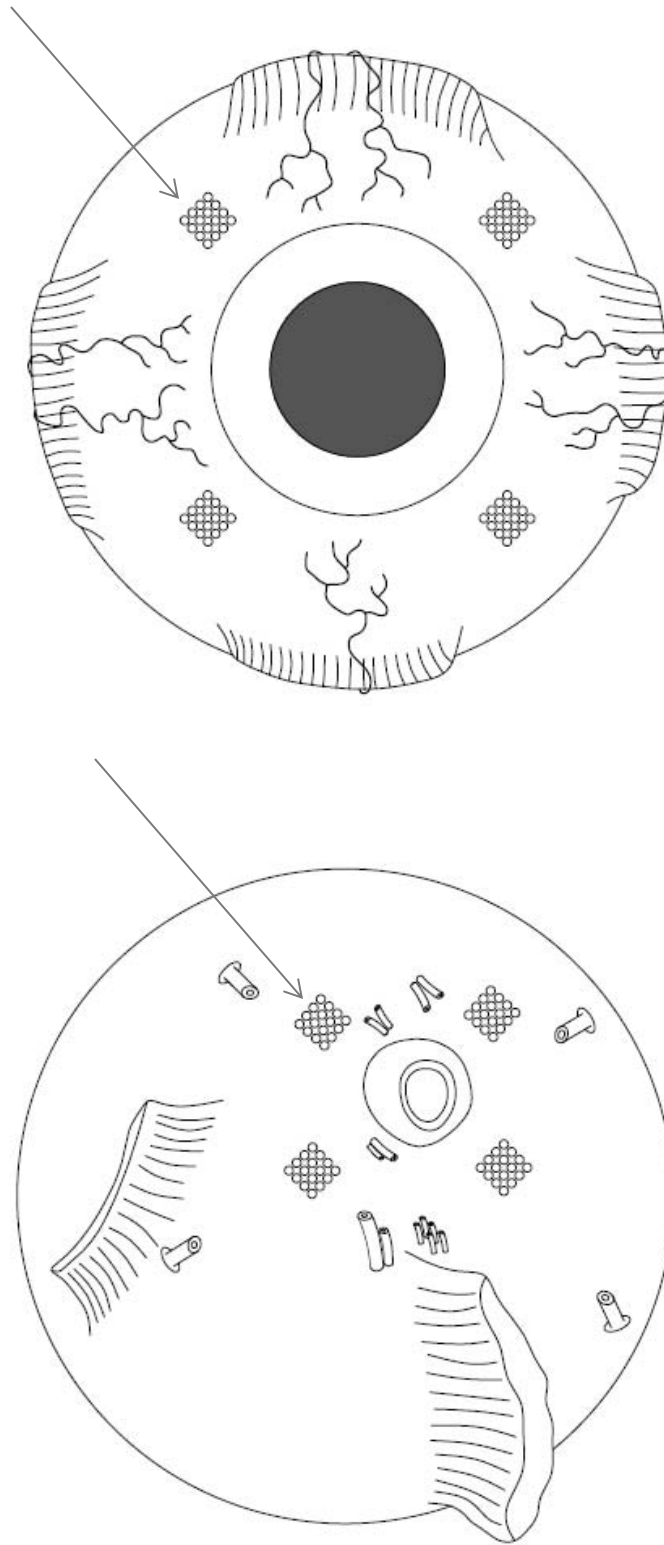


FIG. 200

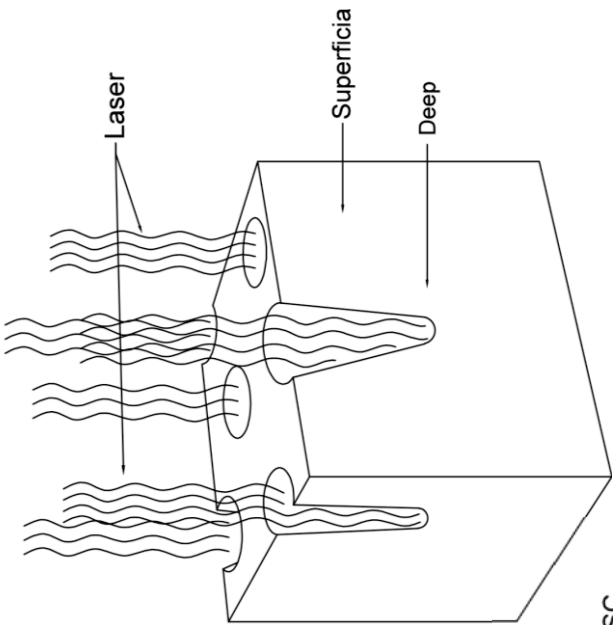
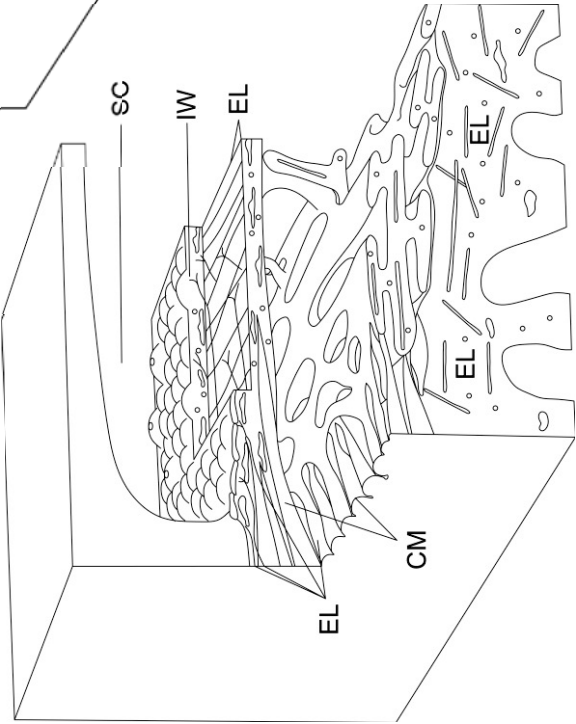


FIG. 20P-3

FIG. 20P-2



ciliary muscle (CM)
elastic (EL)
Schlemm's canal (SC)
inner wall (IW)

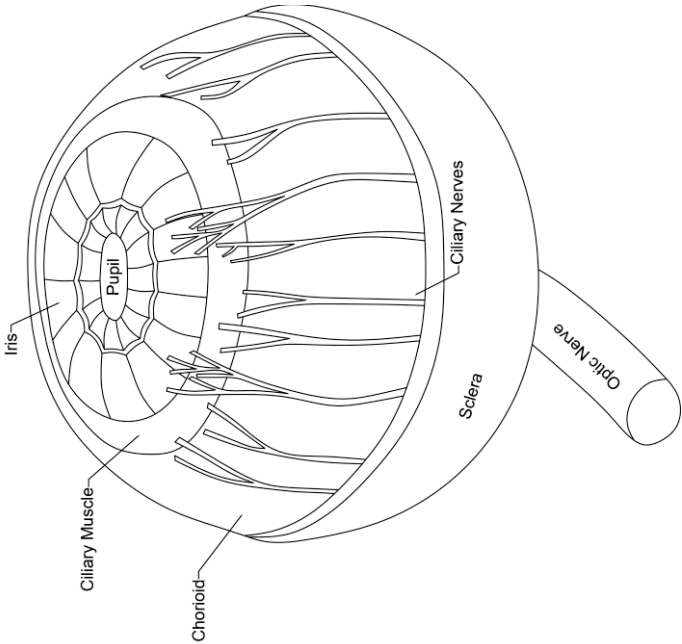


FIG. 20P-1

Transcleral Drug Delivery System (TSDS)

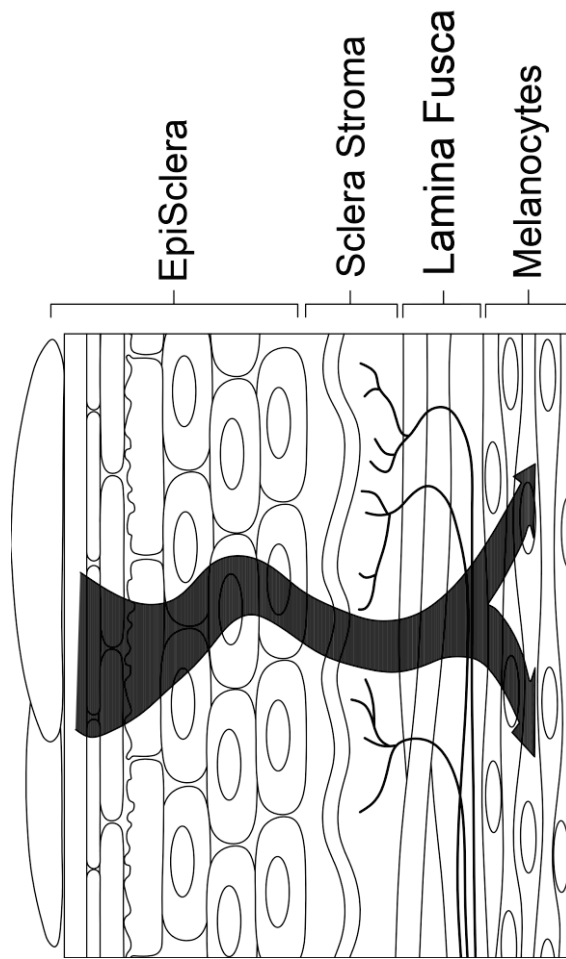


FIG. 20Q-1

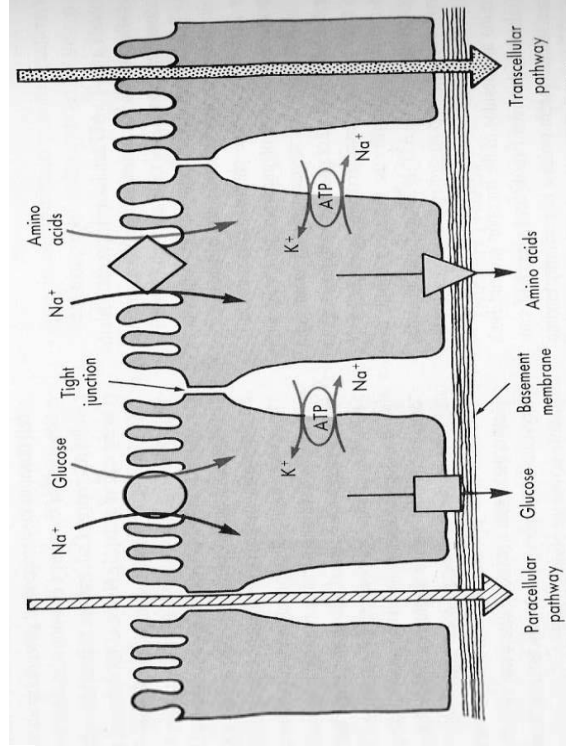


FIG. 20Q-2

Drug intracellular release and penetration

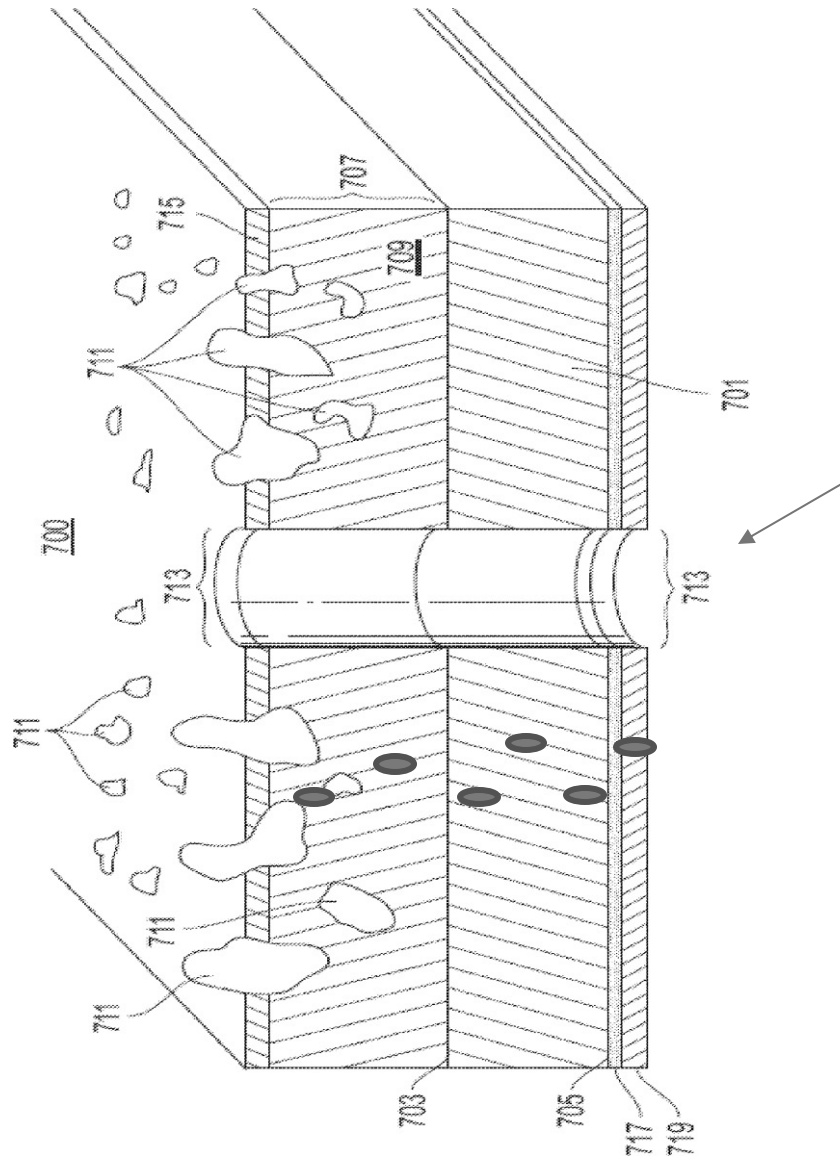


FIG. 20Q-3

Micropore drug penetration

Eye Patch with Micro or Nanovesicle integrated

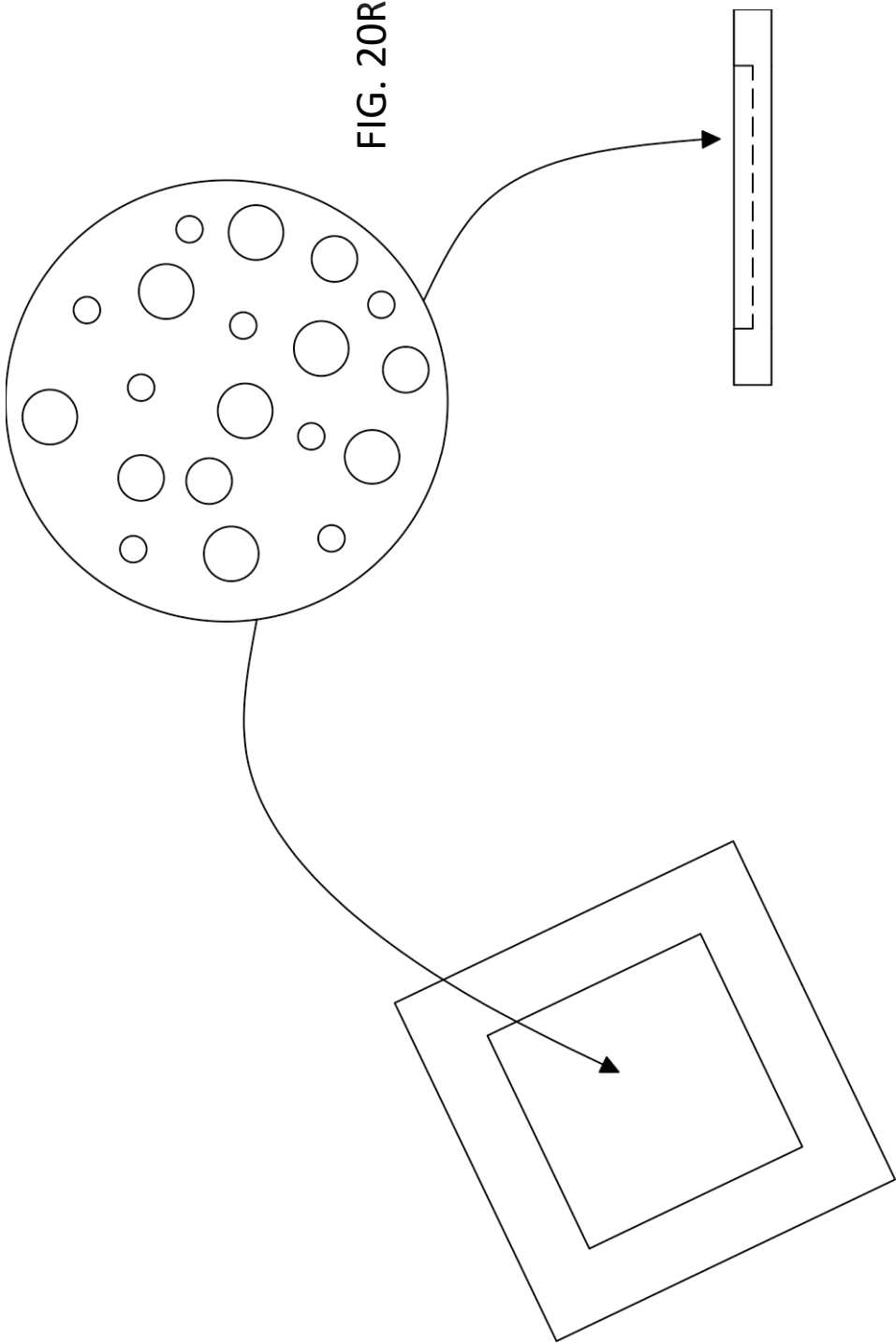
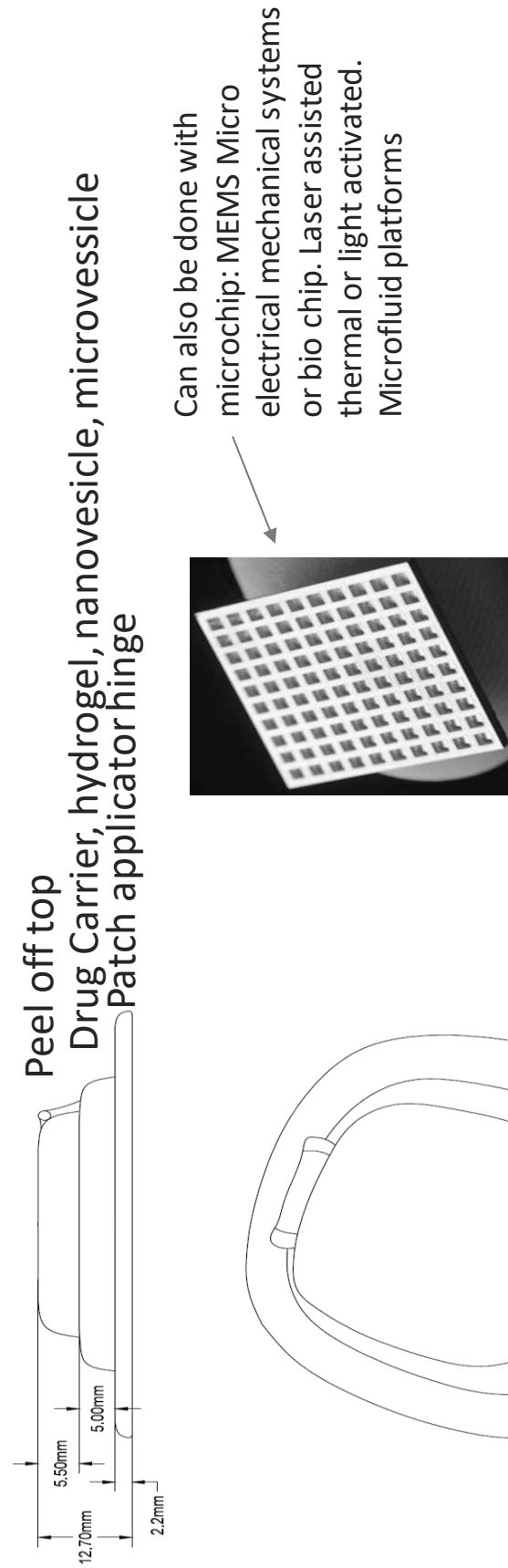


FIG. 20S Disposable Patch with Drug Carrier or BioChip



Each array contains a few milligrams of a specific drug, with the correct dosage released automatically based on a pre-programmed schedule or released in real-time, via a wireless app controlled by the patient or the caregiver.

NanoWafer: 360 scleral wafer

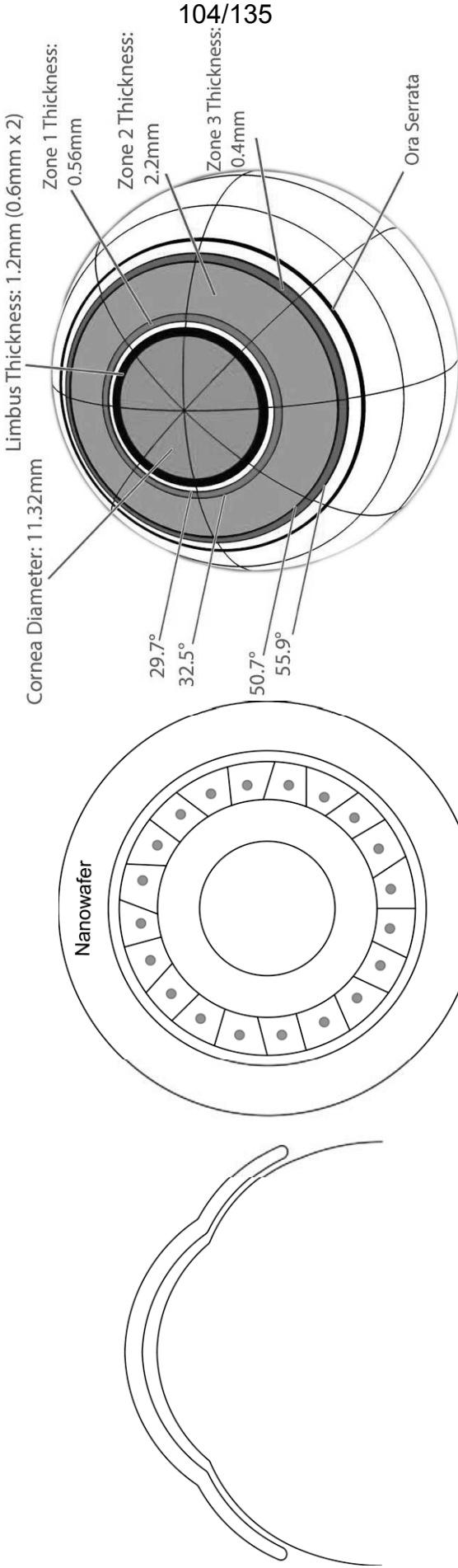


FIG. 20T-1

FIG. 20T-2

FIG. 20T-3

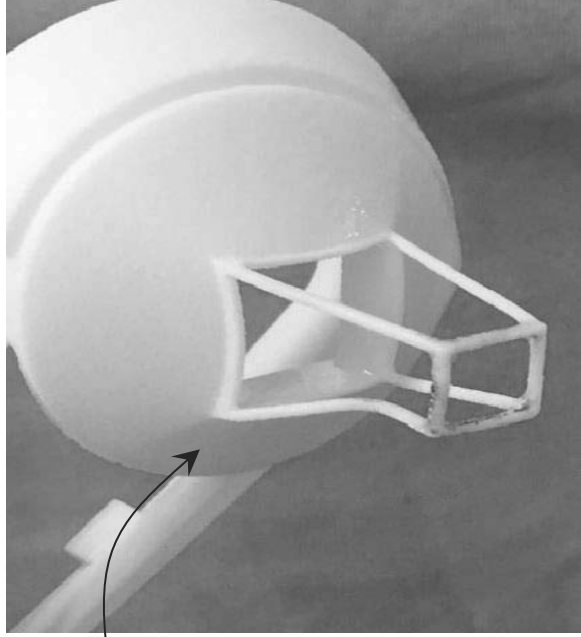


FIG. 21B

2110

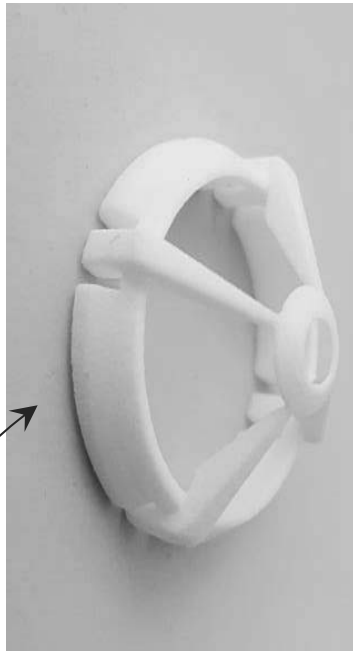


FIG. 21A

2100

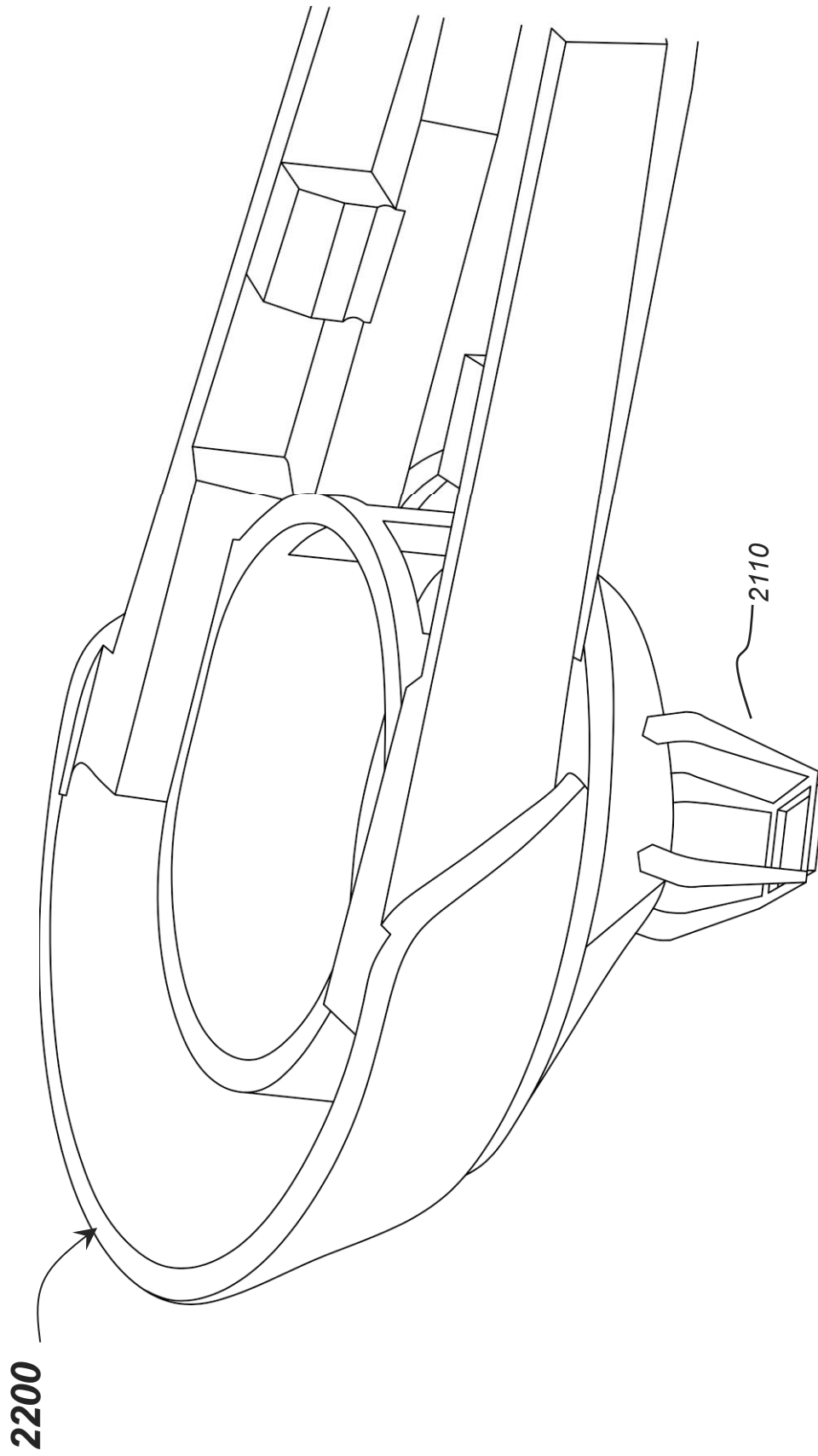


FIG. 22

Nozzle with Filter

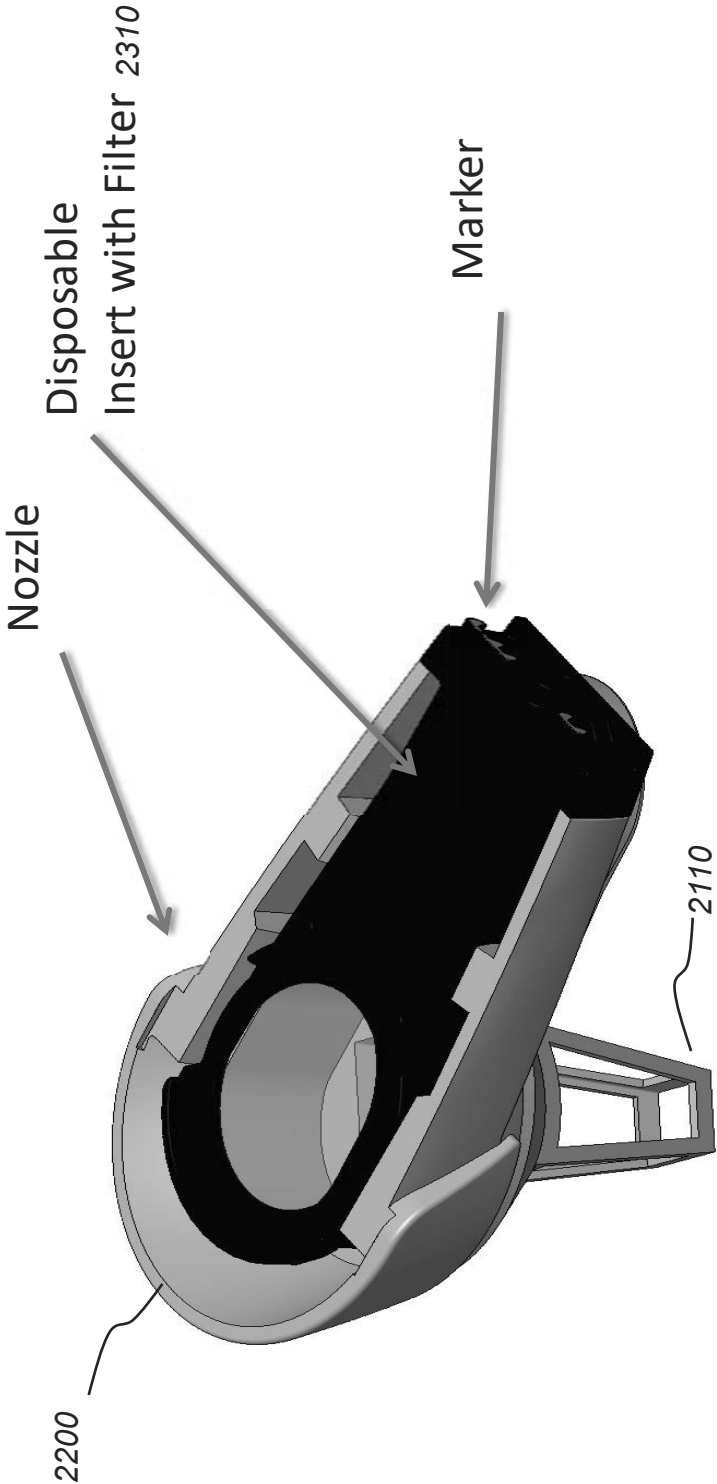
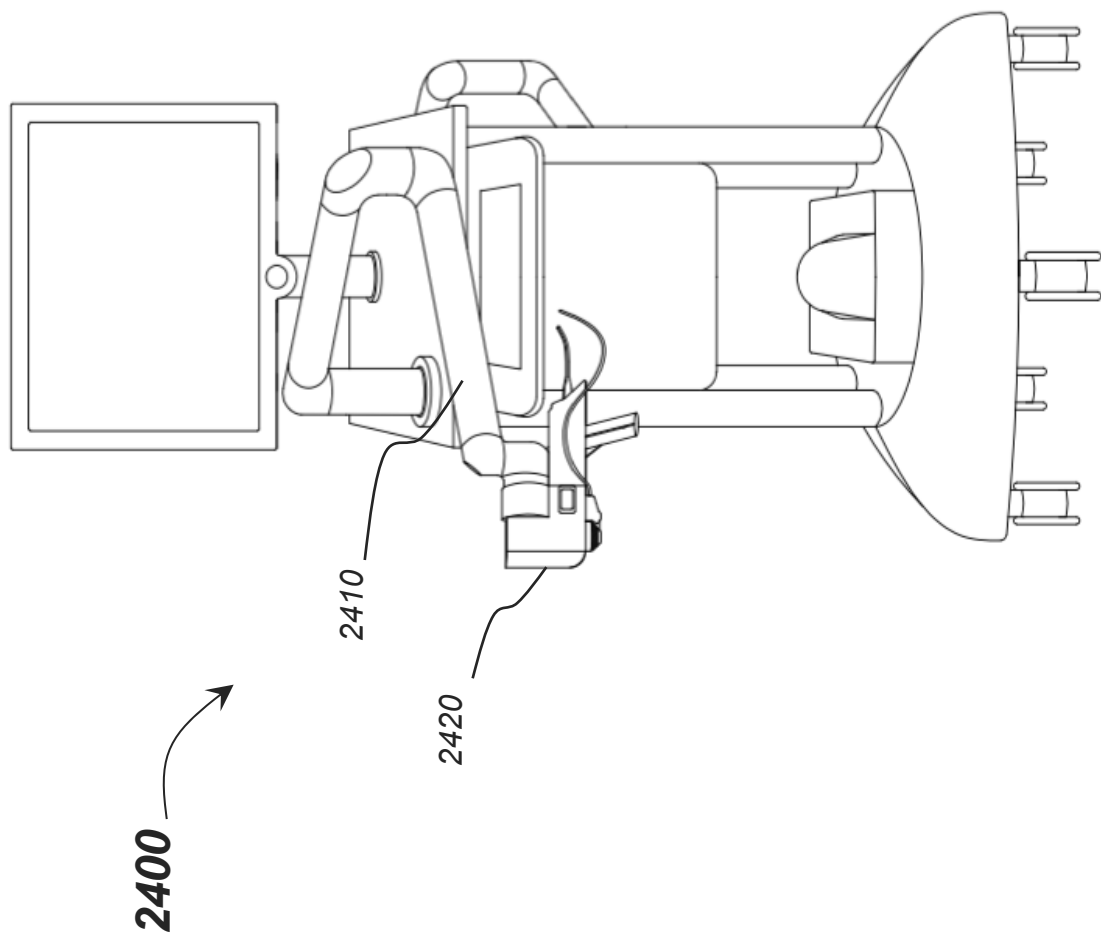


FIG. 23

FIG. 24



Laser Housing

2500

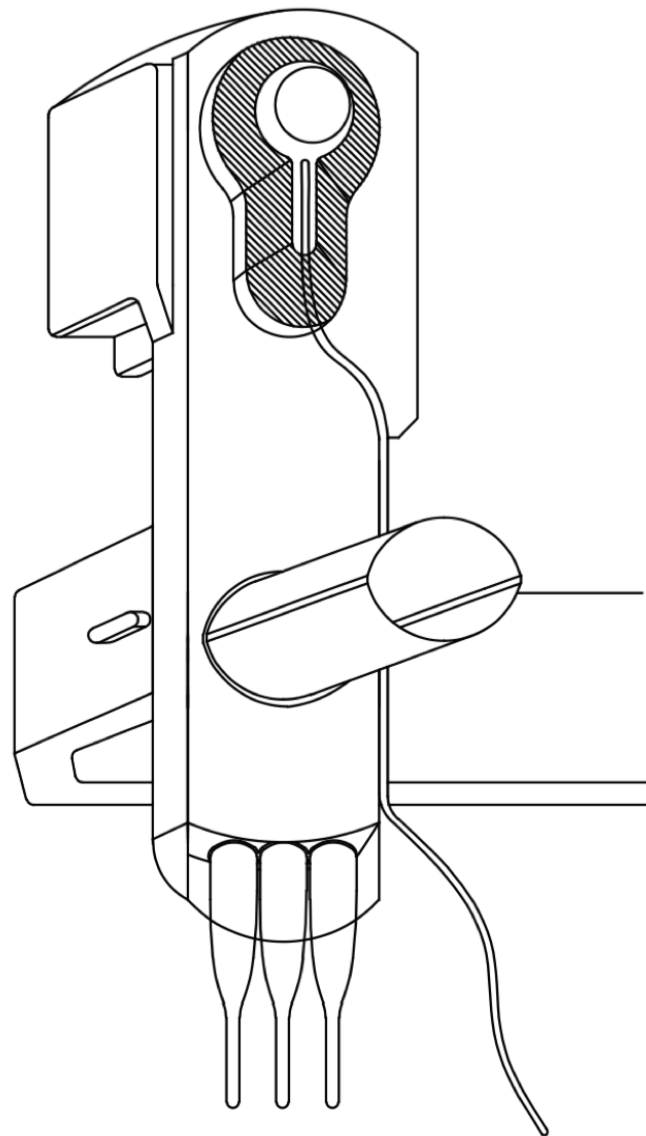
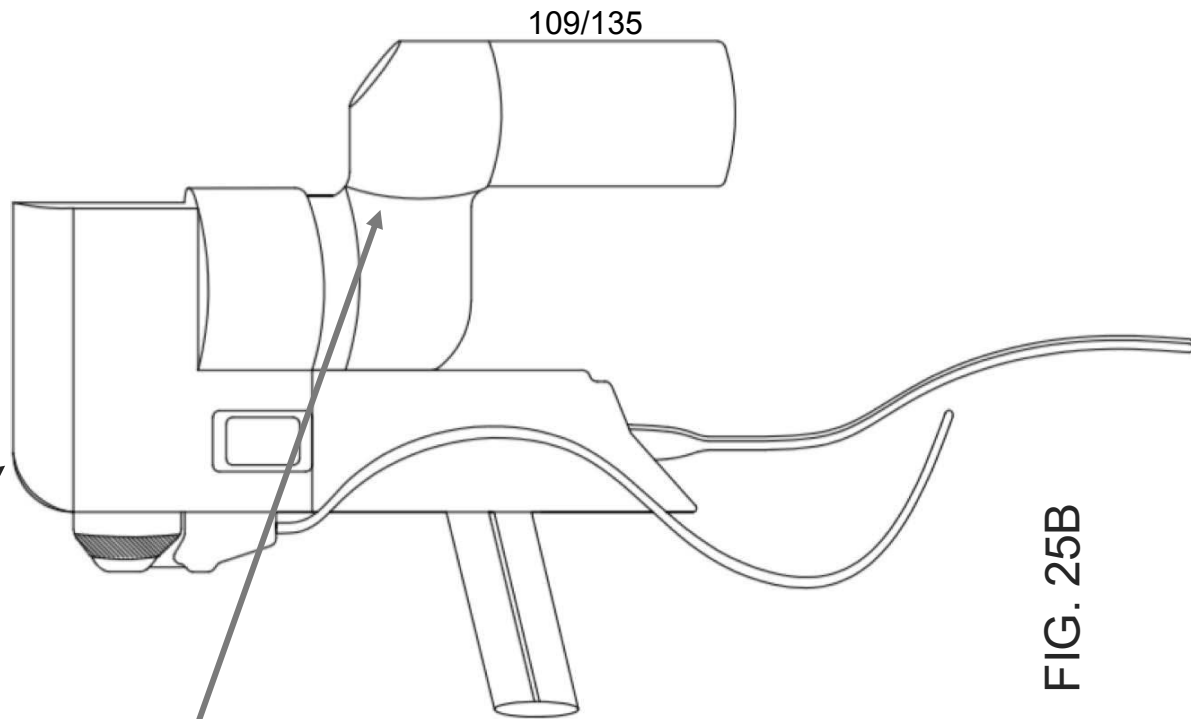


FIG. 25A

2500

360 dg
rotational
joint here



109/135

FIG. 25B

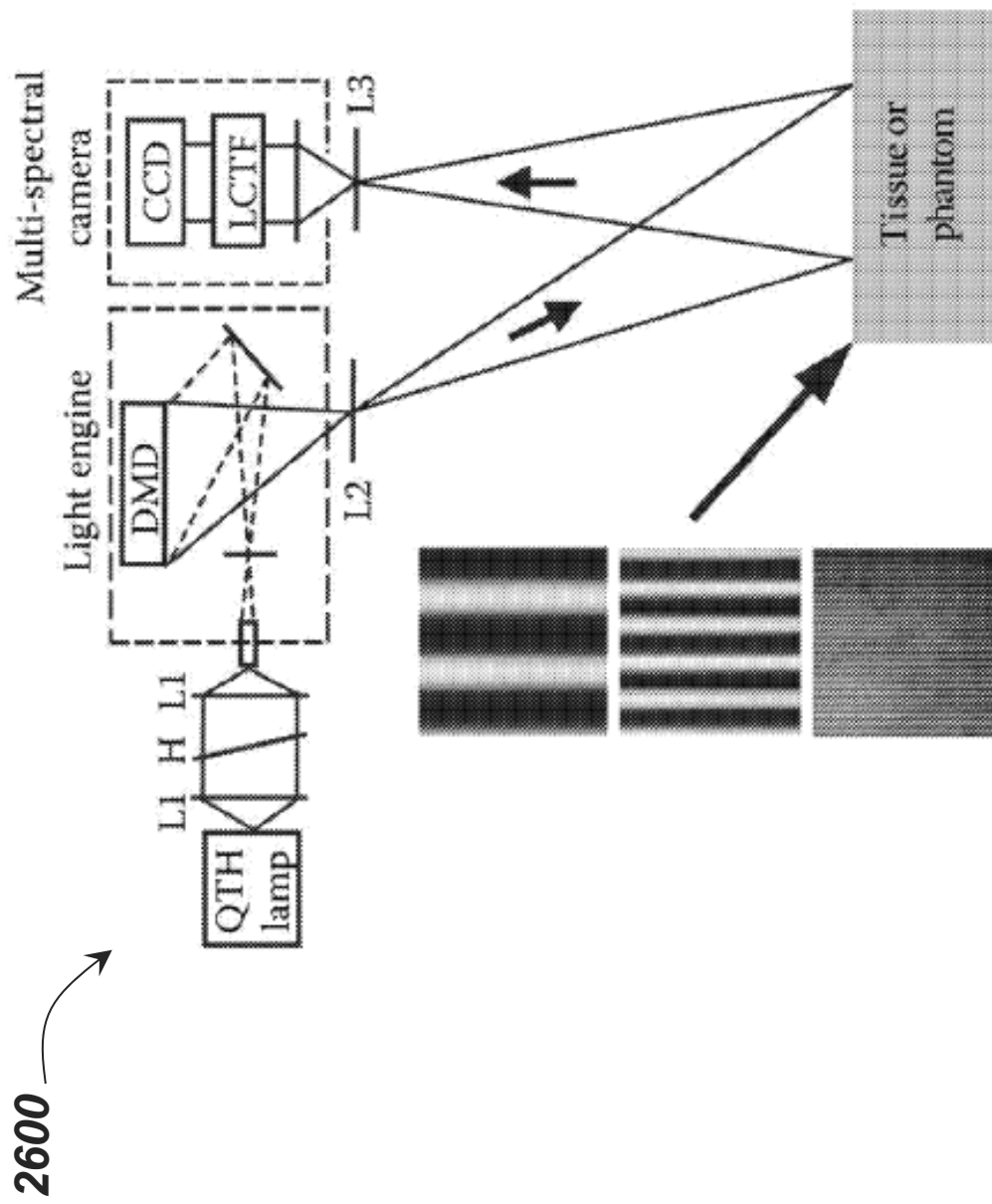


FIG. 26-A

CCD Camera with Nozzle

FIG. 26-B



FIG. 26-C



CCD Camera with Nozzle



FIG. 26-D

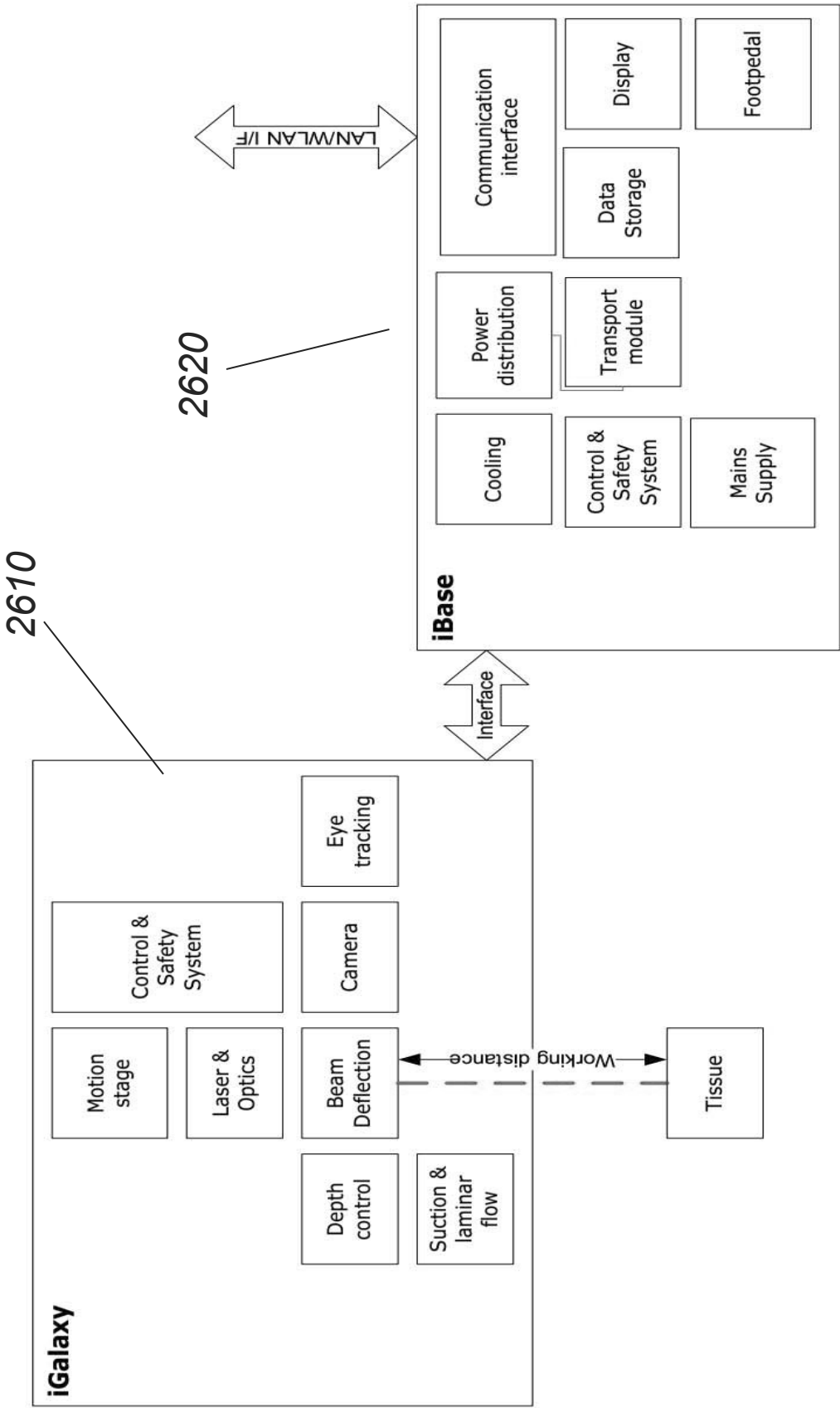
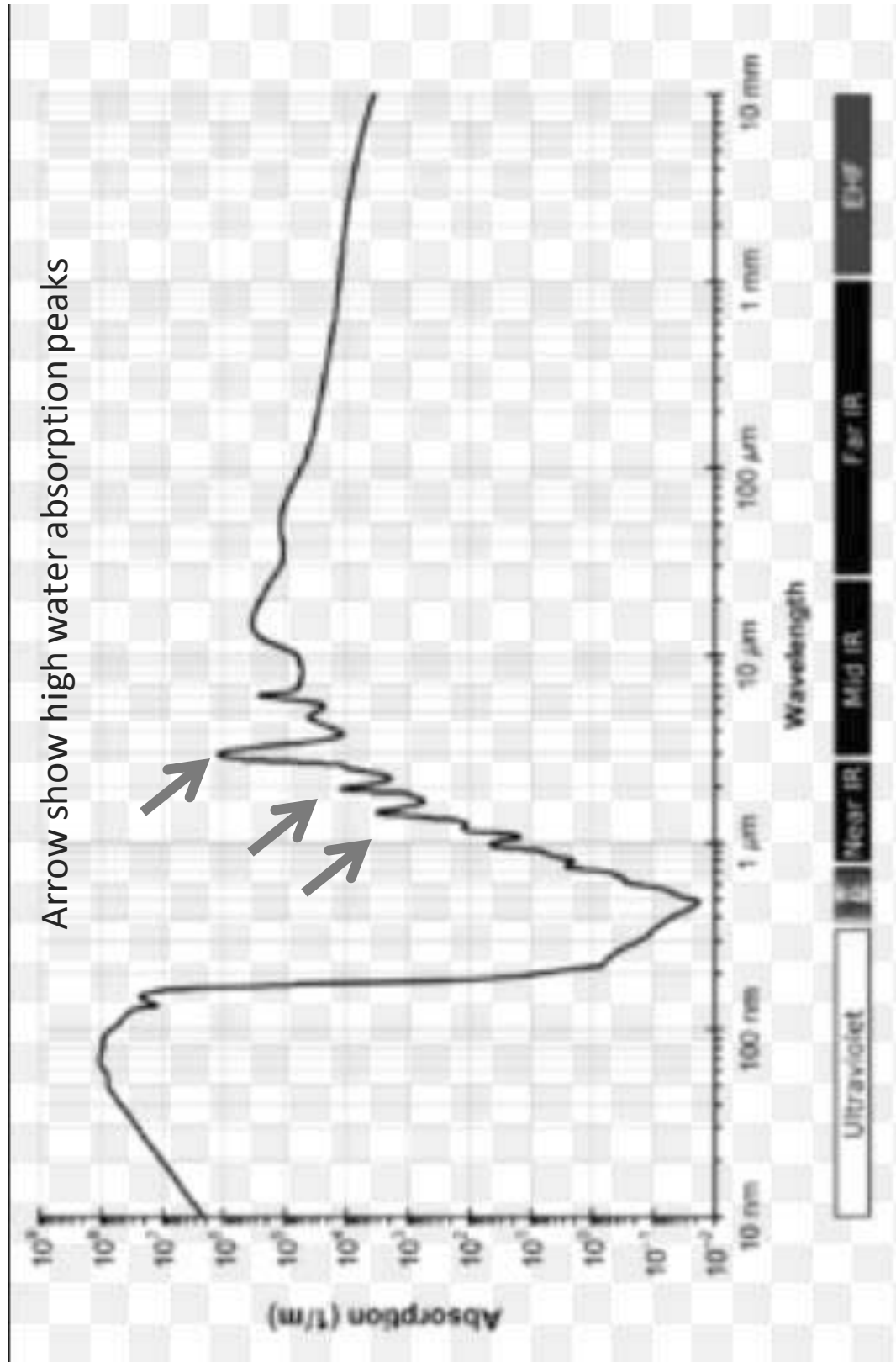
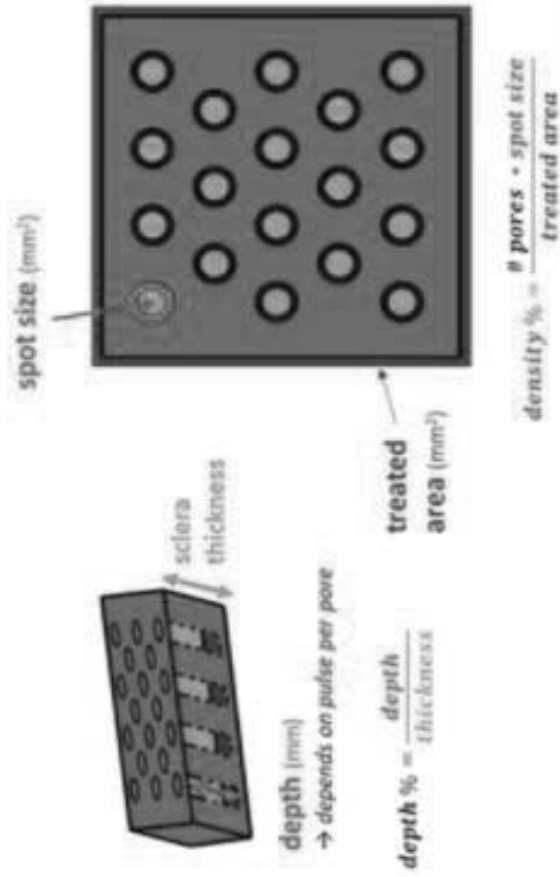


FIG. 26-1

Water Absorption vs Wavelength
 FIG. 26-2



micro parameter definitions



Relationships between parameters
macro input parameters of laser treatment
micro input parameters of laser treatment
properties of the sclera
input to finite element model of treated zones

pore volume fraction = **treated volume** occupied by pores, i.e. sclera volume removed by the laser

$$\text{pore volume fraction} = \frac{\text{total pore volume}}{\text{treated volume}}$$

$$\approx \frac{\text{density \%} \cdot \text{depth}}{\text{thickness}} = \text{density \%} \cdot \text{depth \%}$$

$$\text{treated stiffness} = (1 - \text{pore volume fraction}) \cdot \text{baseline stiffness}$$

$$\text{treated volume} = \text{treated area} \cdot \text{thickness}$$

$$\text{total pore volume} = \text{spot size} \cdot \# \text{ pores} \cdot \text{depth} \approx \text{density \%} \cdot \text{treated area} \cdot \text{depth}$$

$$\text{effective stiffness} = (1 - \text{region fraction} \cdot \text{pore volume fraction}) \cdot \text{baseline stiffness}$$

FIG. 26-3A

array size = side length of the square area of treatment (mm)

treated surface area = surface area of sclera where treatment is applied (mm²)

$$\text{treated surface area} = \text{array}^2$$

thickness = thickness of sclera in the treated area (mm), *assumed uniform*

treated volume = volume of sclera where treatment is applied (mm³)

$$\text{treated volume} = \text{treated surface area} * \text{thickness} = \text{array}^2 * \text{thickness}$$

density % = percent of **treated surface area** occupied by pores (%)

spot size = surface area of one pore (mm²)

pores = number of pores in the treated region

$$\# \text{ pores} = \frac{\text{density \%} * \text{treated surface area}}{\text{spot size} * 100} = \frac{\text{density \%} * \text{array}^2}{\text{spot size} * 100} \quad * \text{round to nearest whole number}$$

total pore surface area = total area within the **treated surface area** occupied by pores

$$\text{total pore surface area} = \text{spot size} * \# \text{ pores} \approx \frac{\text{density \%} * \text{treated surface area}}{100} \approx \frac{\text{density \%} * \text{array}^2}{100}$$

depth = depth of one pore (mm); *dependent on pulse per pore (ppp) parameter*

depth % = percent of the **thickness** extended into by the pore **depth** (%)

$$\text{depth \%} = \frac{\text{depth}}{\text{thickness}} * 100$$

total pore volume = total area within the **treated surface area** occupied by pores

$$\text{total pore volume} = \text{total pore surface area} * \text{depth} = \text{spot size} * \# \text{ pores} * \text{depth} \approx \frac{\text{density \%} * \text{treated surface area} * \text{depth}}{100} \approx \frac{\text{density \%} * \text{array}^2 * \text{depth}}{100}$$

volume fraction = percent of **treated volume** occupied by pores (%), i.e. percent of sclera volume removed by the laser

$$\text{volume fraction} = \frac{\text{total pore volume}}{\text{treated volume}} * 100 \approx \frac{\text{density \%} * \text{depth}}{\text{thickness}} = \frac{\text{density \%} * \text{depth \%}}{100}$$

Relationships between treatment parameters

input parameters of laser treatment

properties of the sclera (thickness)

input to calculate new stiffness (volume fraction)

FIG. 26-3A1

Calculating new stiffness of sclera in the treated region

volume fraction = percent of **treated volume** occupied by pores (%), i.e. percent of sclera volume removed by the laser

$$\text{volume fraction} = \frac{\text{total pore volume}}{\text{treated volume}} * 100 \approx \frac{\text{density \% * depth}}{\text{thickness}} = \frac{\text{density \% * depth \%}}{100}$$

stiffness = modulus of elasticity of sclera before treatment (MPa)

treated stiffness = modulus of elasticity of sclera after treatment (MPa); estimated from microscale mixture model

$$\text{treated stiffness} = \left(1 - \frac{\text{volume fraction}}{100}\right) * \text{stiffness} \approx \left(1 - \frac{\text{density \% * depth}}{\text{thickness} * 100}\right) * \text{stiffness} = \left(1 - \frac{\text{density \% * depth \%}}{10000}\right) * \text{stiffness}$$

input parameters of laser treatment

properties of the sclera

input to calculate new stiffness

input to finite element model of treated zones

FIG. 26-3A2

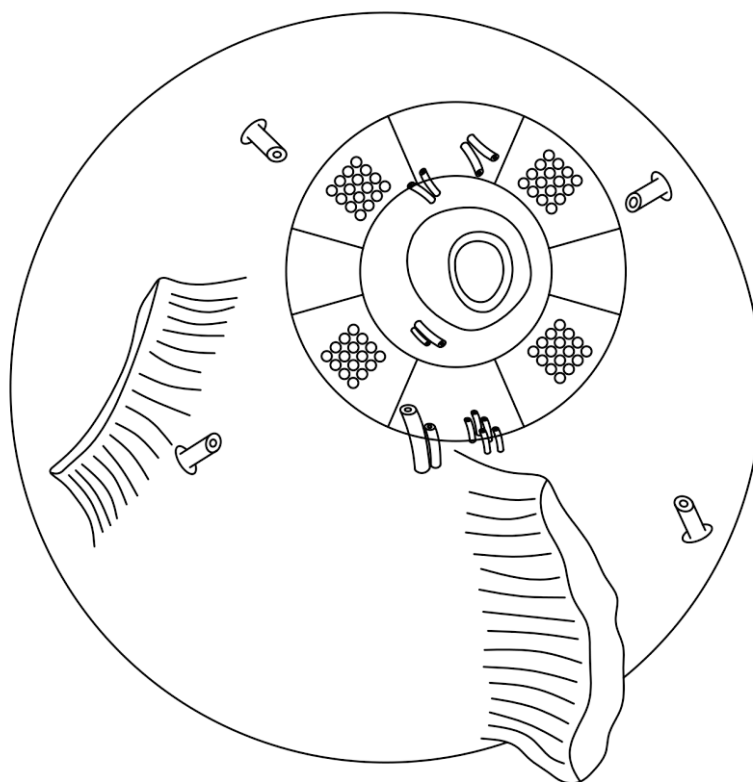
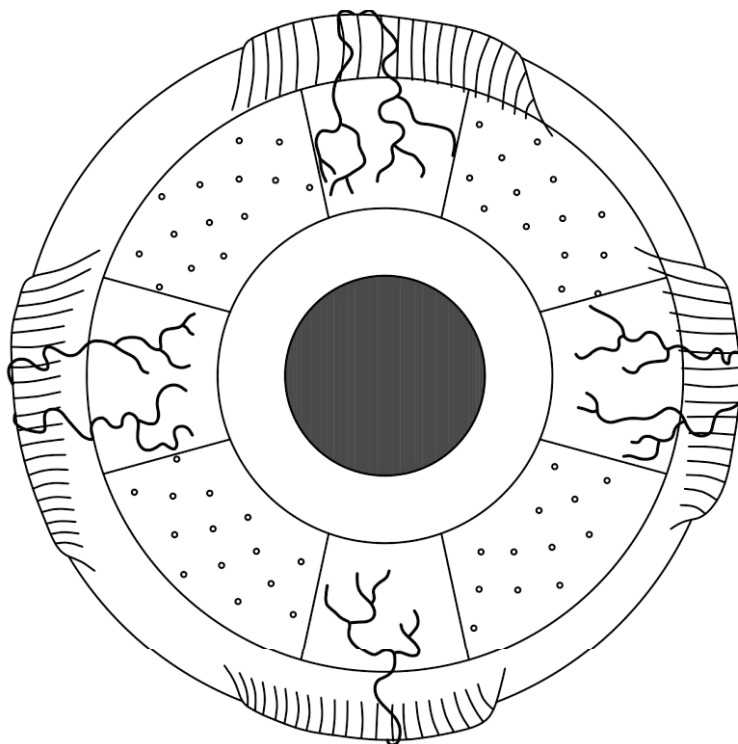


FIG. 26-4

effect of treatment density on ciliary deformation in accommodation

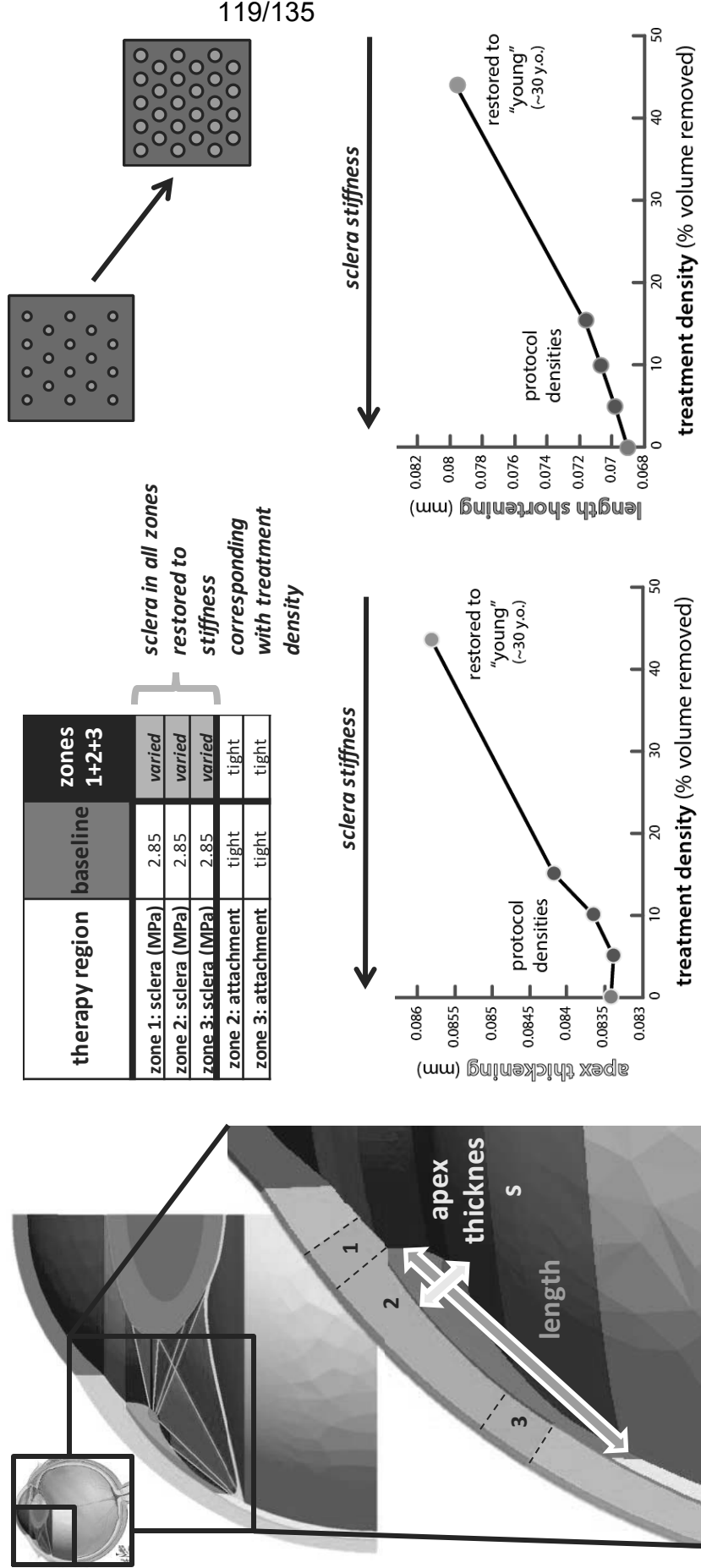


FIG. 26-4-1

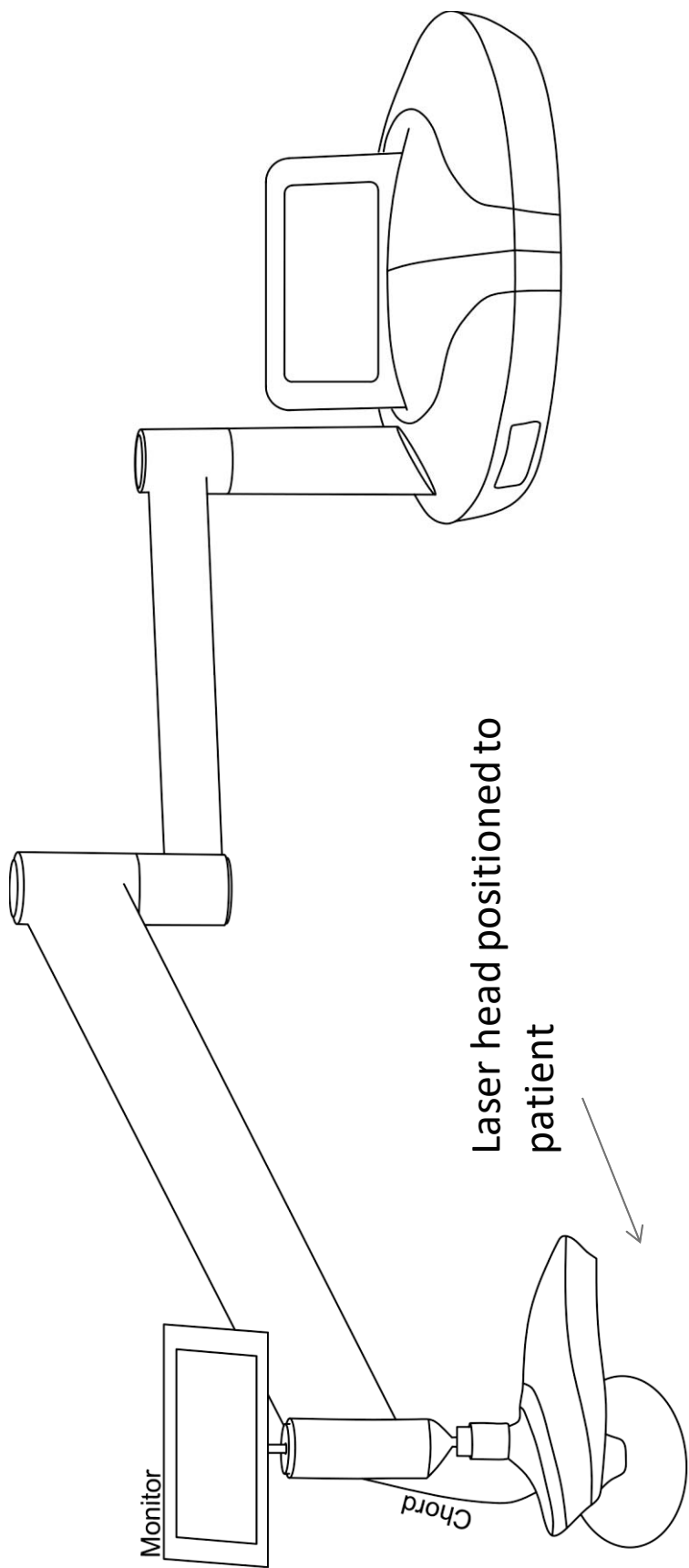


FIG. 26-5

Protection Lens/Eye Mask

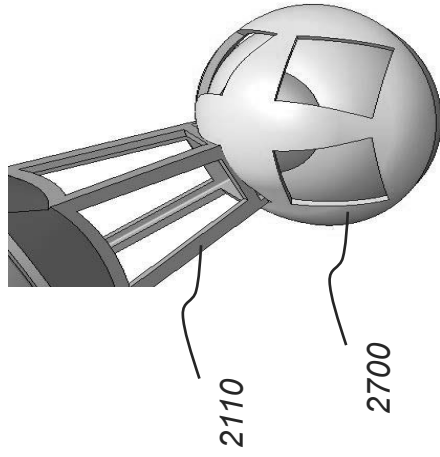


FIG. 27A

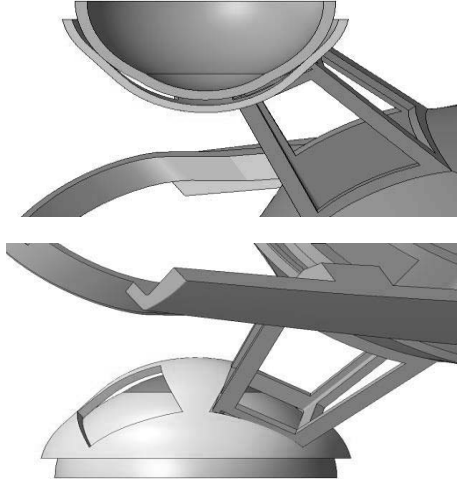


FIG. 27B

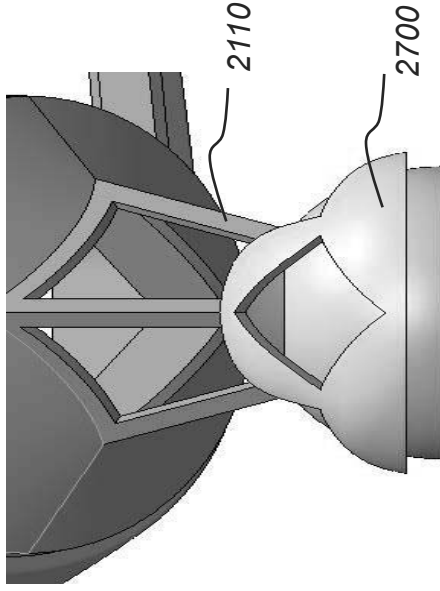


FIG. 27C

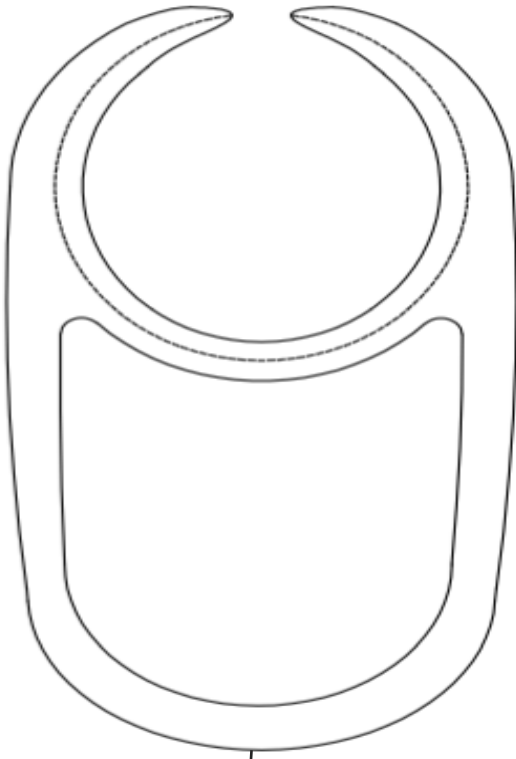


FIG. 28B

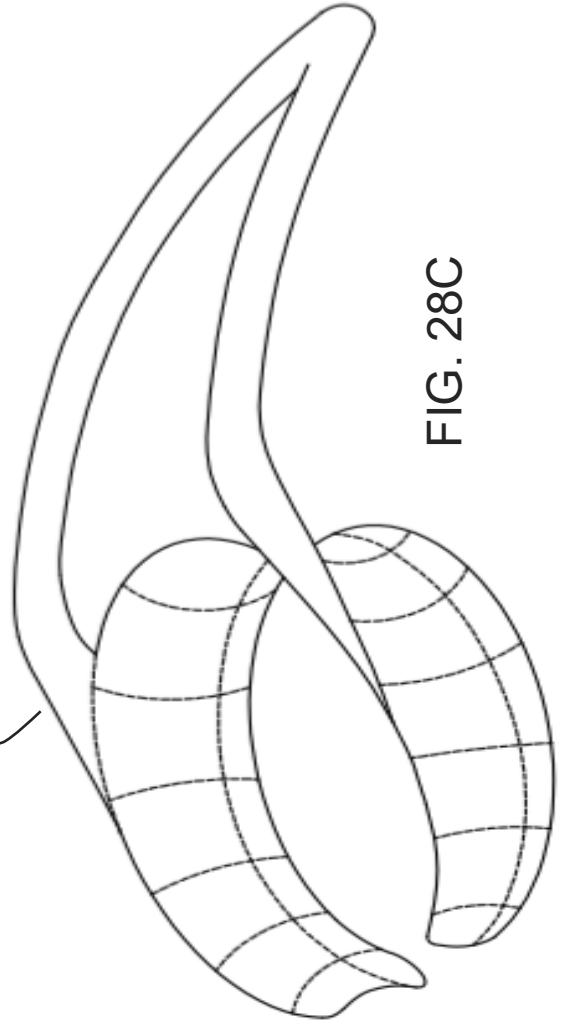


FIG. 28C

Speculum

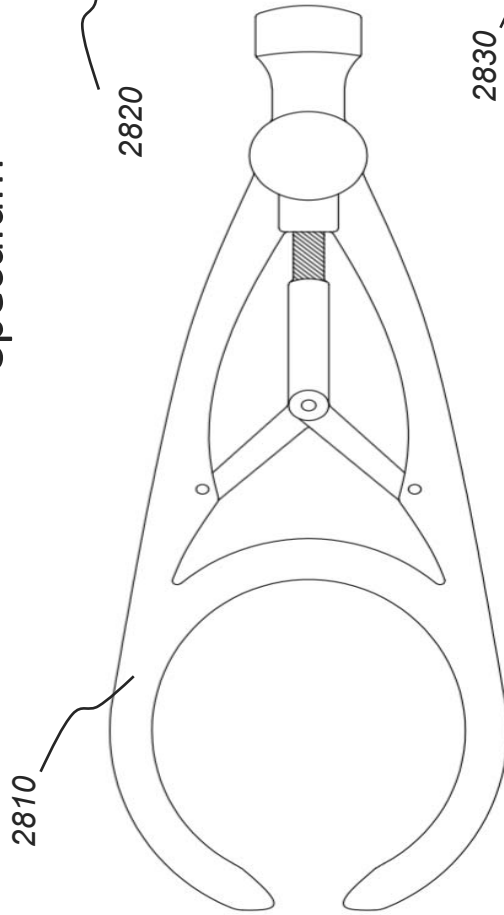
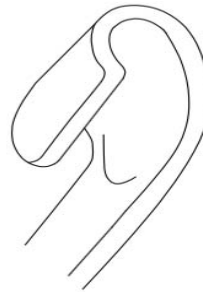


FIG. 28A



Speculum with the lid
holders extended to open the
eye up more

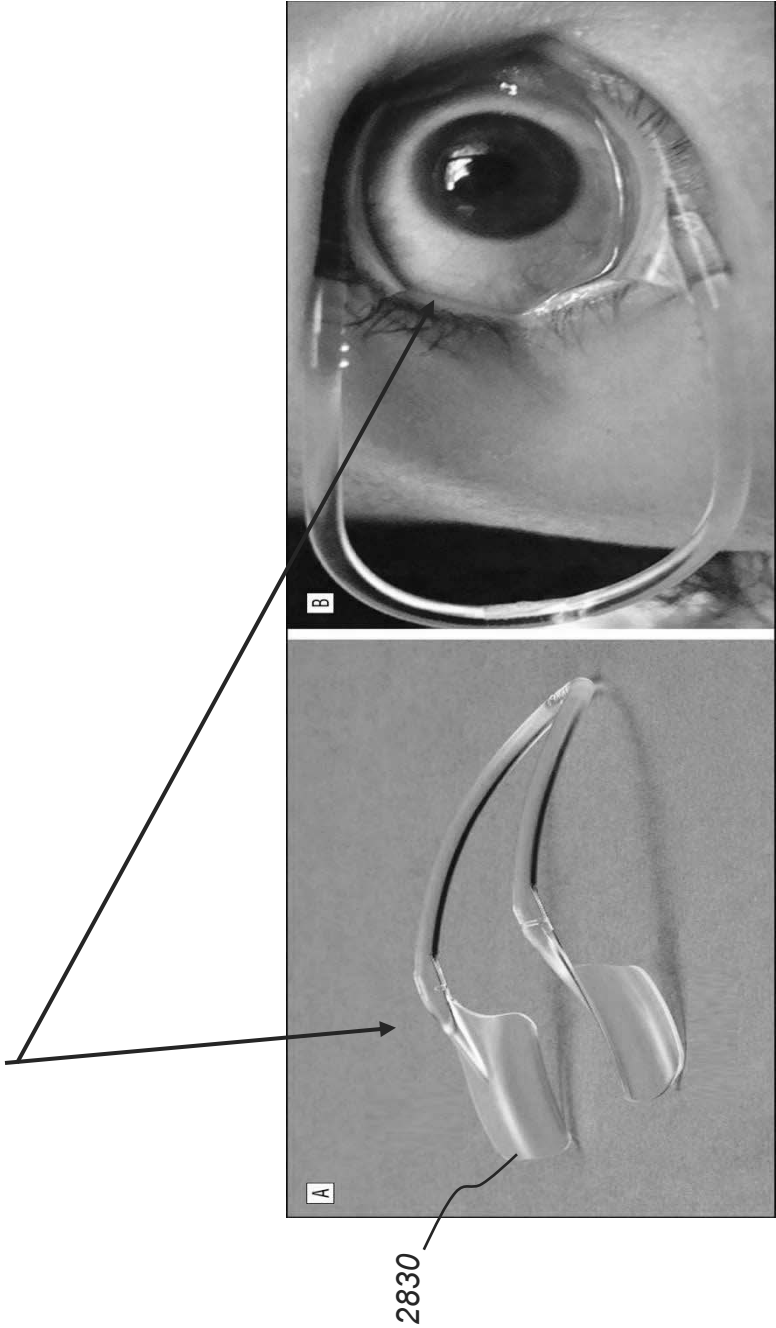


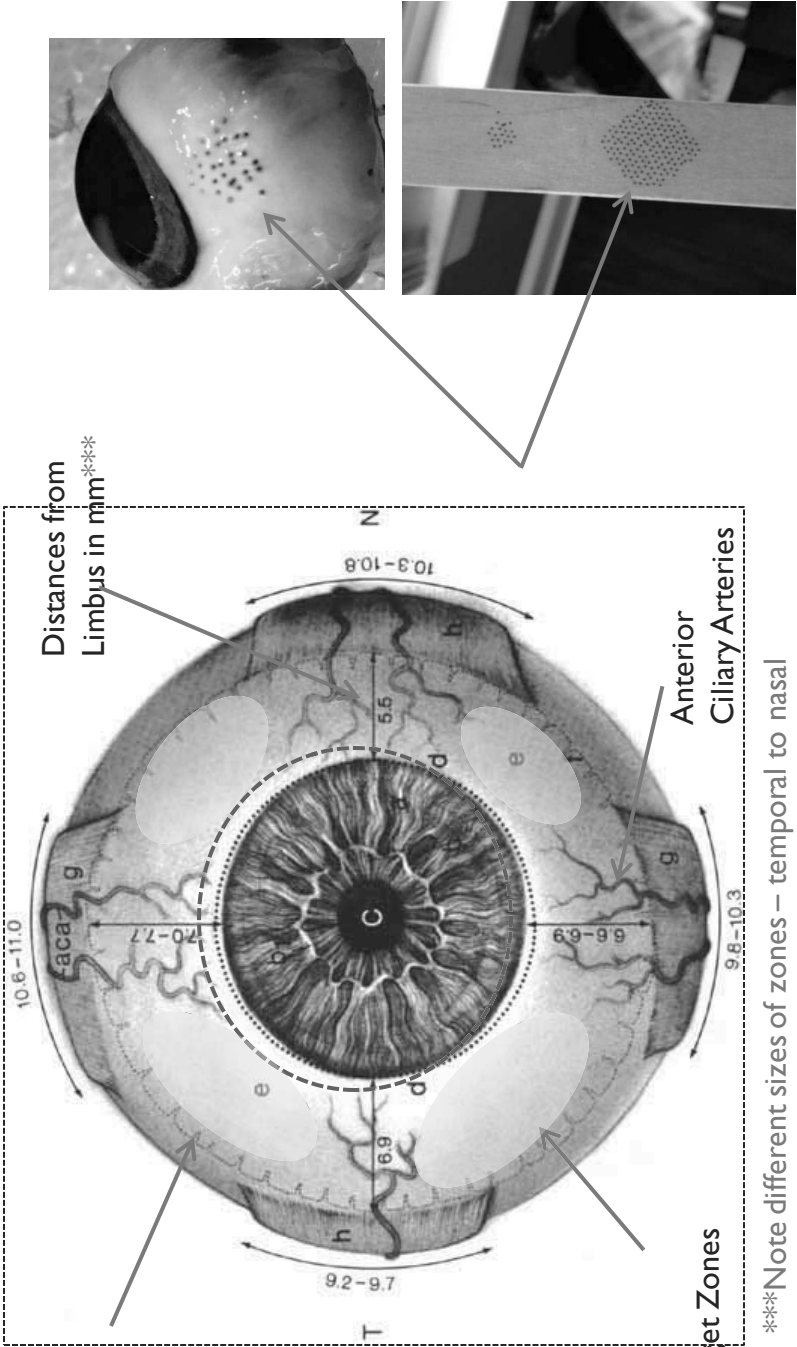
FIG. 29A

FIG. 29B

anatomy avoidance in laser section

Laser System
Proposed Test Assumptions:

System Testing:



Ora Serrata

1. Cover entire Target area with Semi-automation of the creation of matrix using 225um
2. Ability to modify Density, Energy and all laser parameters with existing software.
3. Technology for Depth Control already developed tested in the lab.

Yellow = Target Zones for Ablation

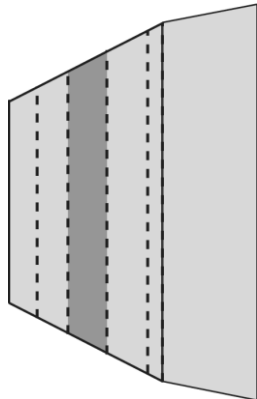
***Note different sizes of zones – temporal to nasal

FIG. 30

treatment parameters:

MACRO

specific to the treatment region, independent of pores



zone dimensions



contribute to region fraction

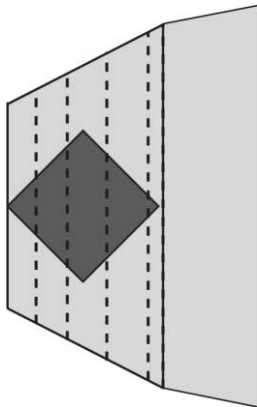


determine effective stiffness

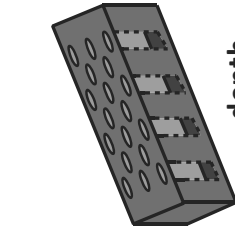
VS

MICRO

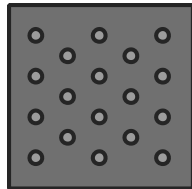
specific to the pores, independent of treatment region



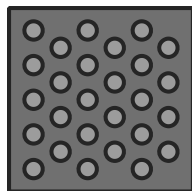
treatment area shape and size



depth



spot size



pores



contribute to pore volume fraction



determines treated stiffness

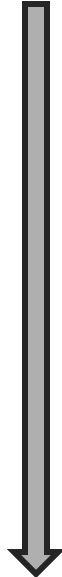
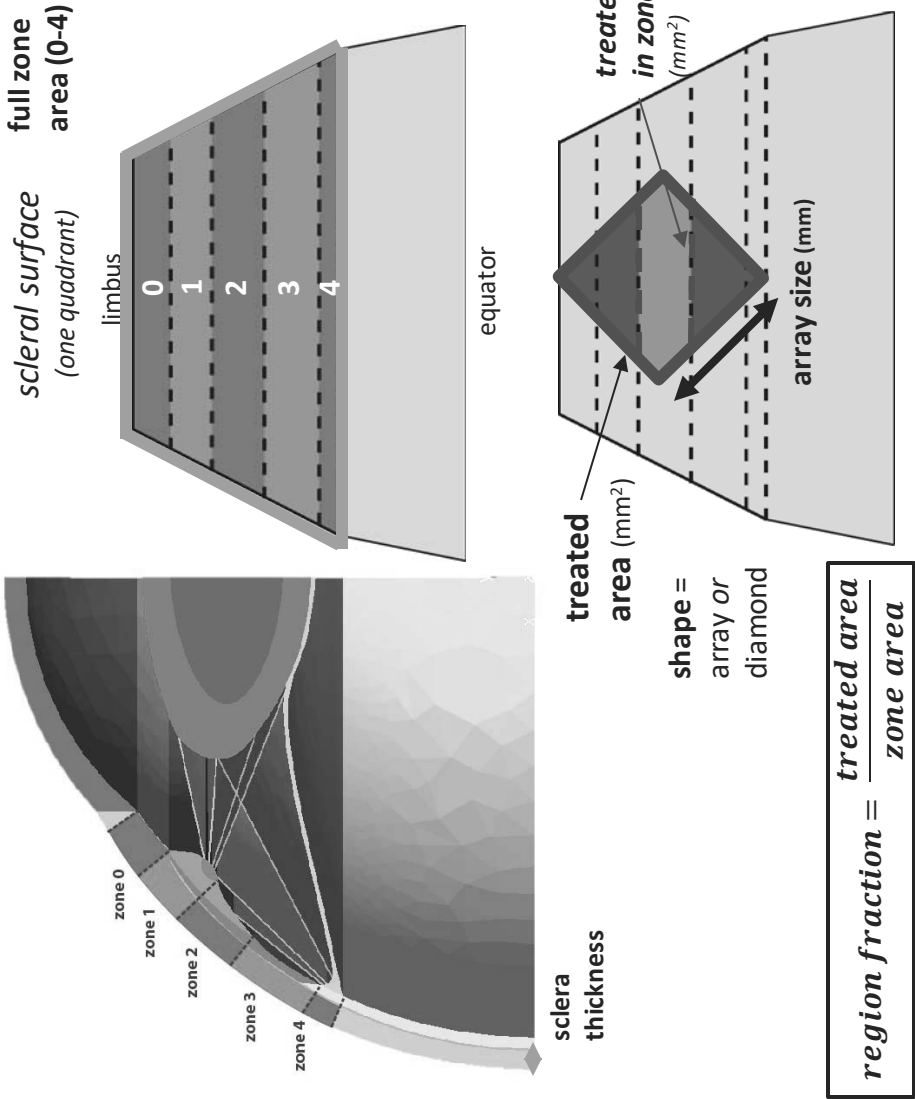


FIG. 31

macro parameter definitions



Relationships between parameters
macro input parameters of laser treatment
micro input parameters of laser treatment
properties of the sclera
input to finite element model of treated zones

effective stiffness =
baseline stiffness * (1 - region fraction)
+ treated stiffness * region fraction

*effective stiffness is needed for each zone in finite element model

treated stiffness
 $= \left(1 - \frac{\text{density \%} * \text{depth}}{\text{thickness}}\right) * \text{baseline stiffness}$

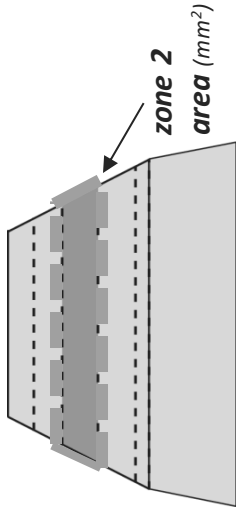


FIG. 32

Different treatment region shapes applied to one sclera quadrant with reference to 5 critical 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

*values in original accommodation model

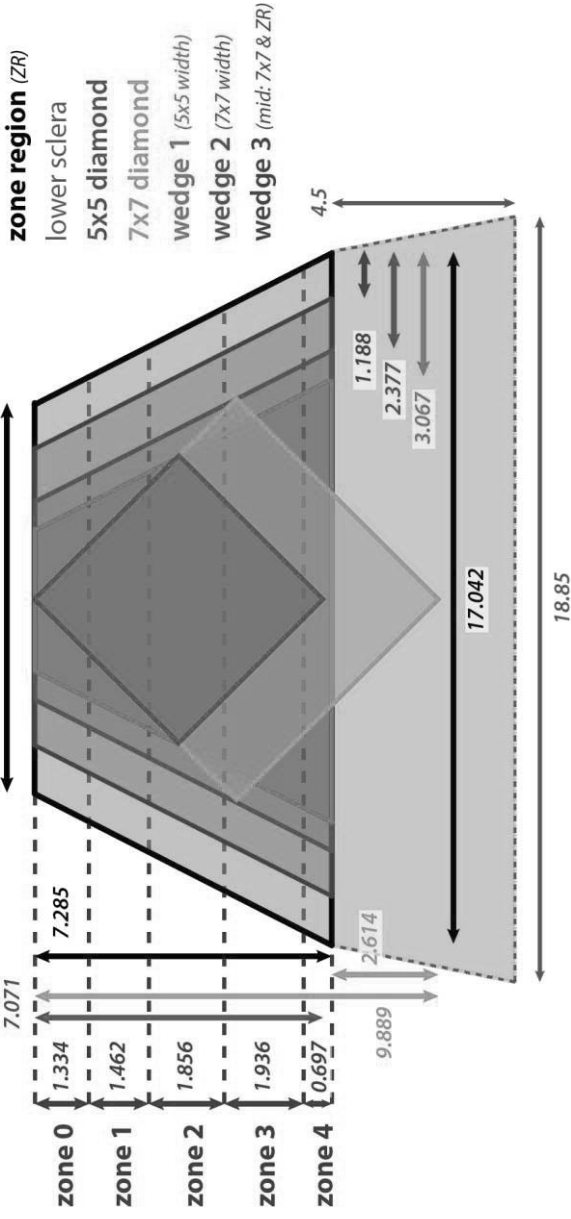
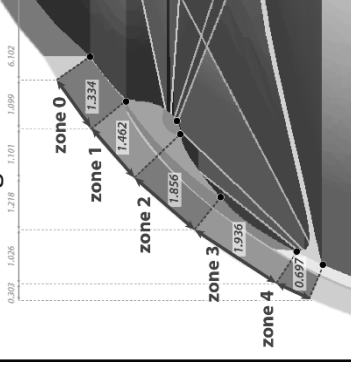
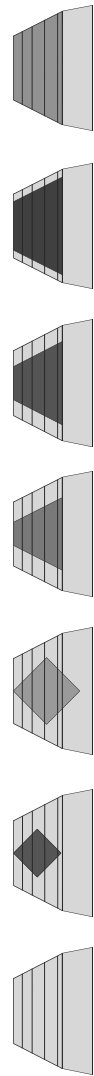


FIG. 33

effect of *shape* treatment on ciliary deformation in accommodation:
sclera stiffness only



Therapy Parameters	baseline	5x5	7x7	wedge 1	wedge 2	wedge 3	full zone area (0-4)
zone 0: sclera (MPa)	2.85	2.6888	2.6888	2.354	2.1804	1.8952	1.61
zone 1: sclera (MPa)	2.85	2.416	2.416	2.2548	2.1184	1.858	1.61
zone 2: sclera (MPa)	2.85	2.292	2.168	2.1804	2.044	1.8332	1.61
zone 3: sclera (MPa)	2.85	2.6144	2.168	2.106	1.9944	1.796	1.61
zone 4: sclera (MPa)	2.85	2.8252	2.416	2.0688	1.9572	1.7836	1.61
lower sclera (MPa)	2.85	2.85	2.7508	2.85	2.85	2.85	2.85

* tight attachment

baseline stiffness: modulus of elasticity (E) = 2.85 MPa (equivalent to ~50 years)

treated stiffness: modulus of elasticity (E) = 1.61 MPa (equivalent to ~30 years old)

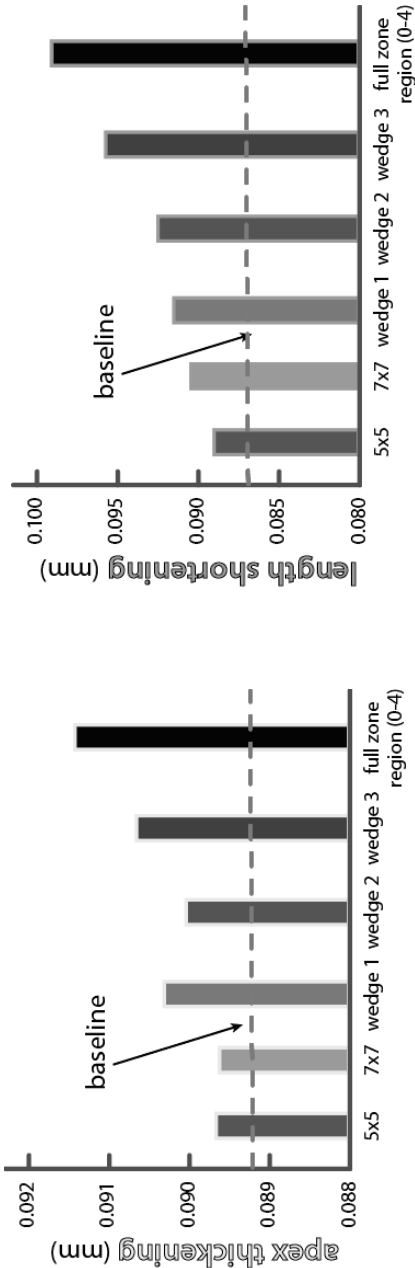
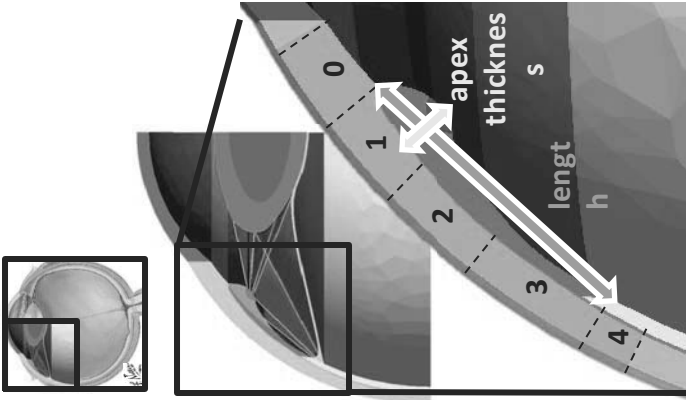
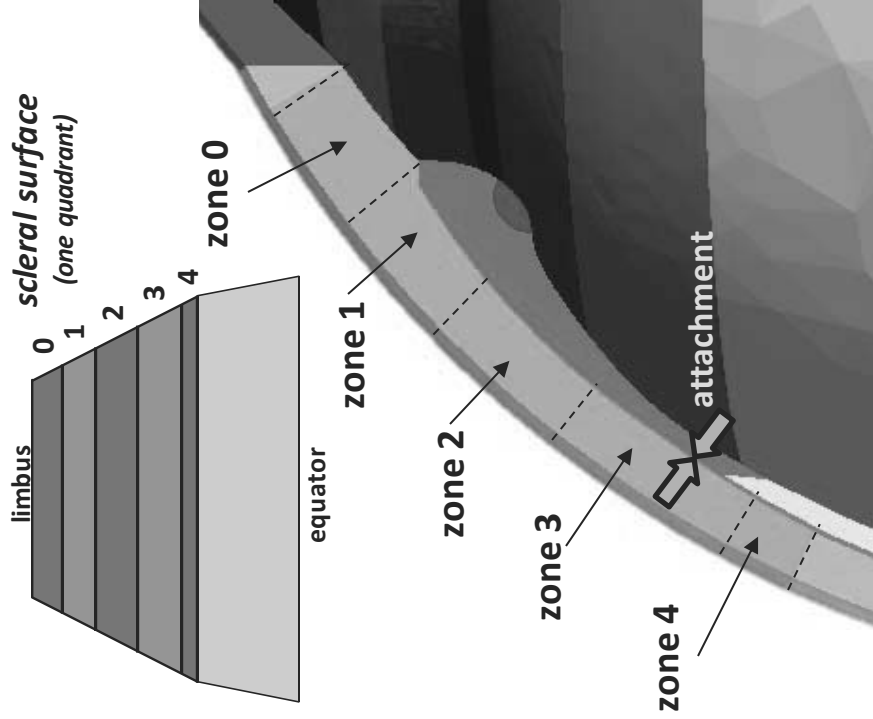


FIG. 34

therapy simulation methods: macro results



baseline simulation: original model of healthy accommodation with “old” sclera

- **stiff** baseline 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.)

zone treatment simulations: baseline model with sclera stiffness and attachment tightness altered in individual full zones

- treated combinations of **zones** (with & w/o changing attachment): individually: 0, 1, 2, 3, 4; combined: 1+2+3, 1+2+3+4, 0+1+2+3+4
- **effective stiffness**: modulus of elasticity (E) = 1.61 MPa, equivalent to ~30 years old*
- **loose** attachment between the sclera and the ciliary/choroid*

*values in original accommodation model

FIG. 35

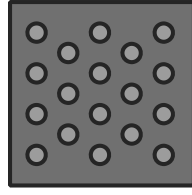
FIG. 36

therapy simulation methods: micro results

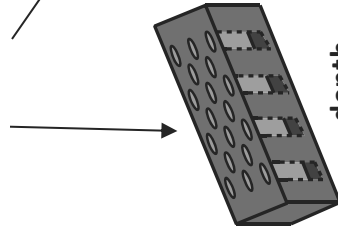
treated stiffness dependent on

pore volume fraction in the treated region

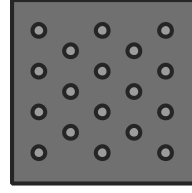
→ % sclera volume removed by treatment



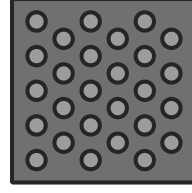
pore volume fraction is varied by changing parameters of ablation holes



depth

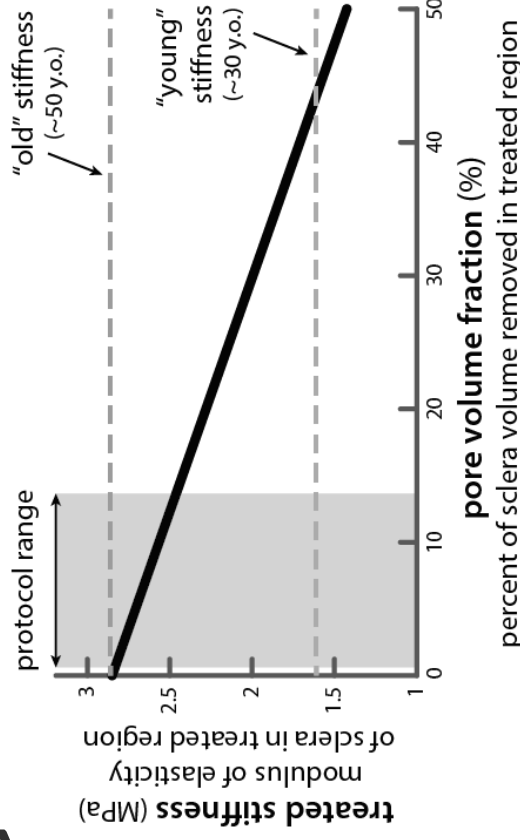


spot size



pores

- resultant stiffness estimated as microscale mixture
- holes assumed to be parallel evenly spaced/sized within volume = volume fraction (% of total sclera volume)
 - remaining volume is "old" sclera ($E = 2.85$ MPa)



- need to remove ~43.5% of volume to change sclera stiffness in the treated area from old (50 y.o.) to young (30 y.o.)
- protocols (combinations of density % & depth) allow for a maximum volume fraction of 13.7%, equivalent to a new stiffness of 2.46 MPa

FIG. 37

effect of volume fraction on ciliary deformation in accommodation:
sclera stiffness only

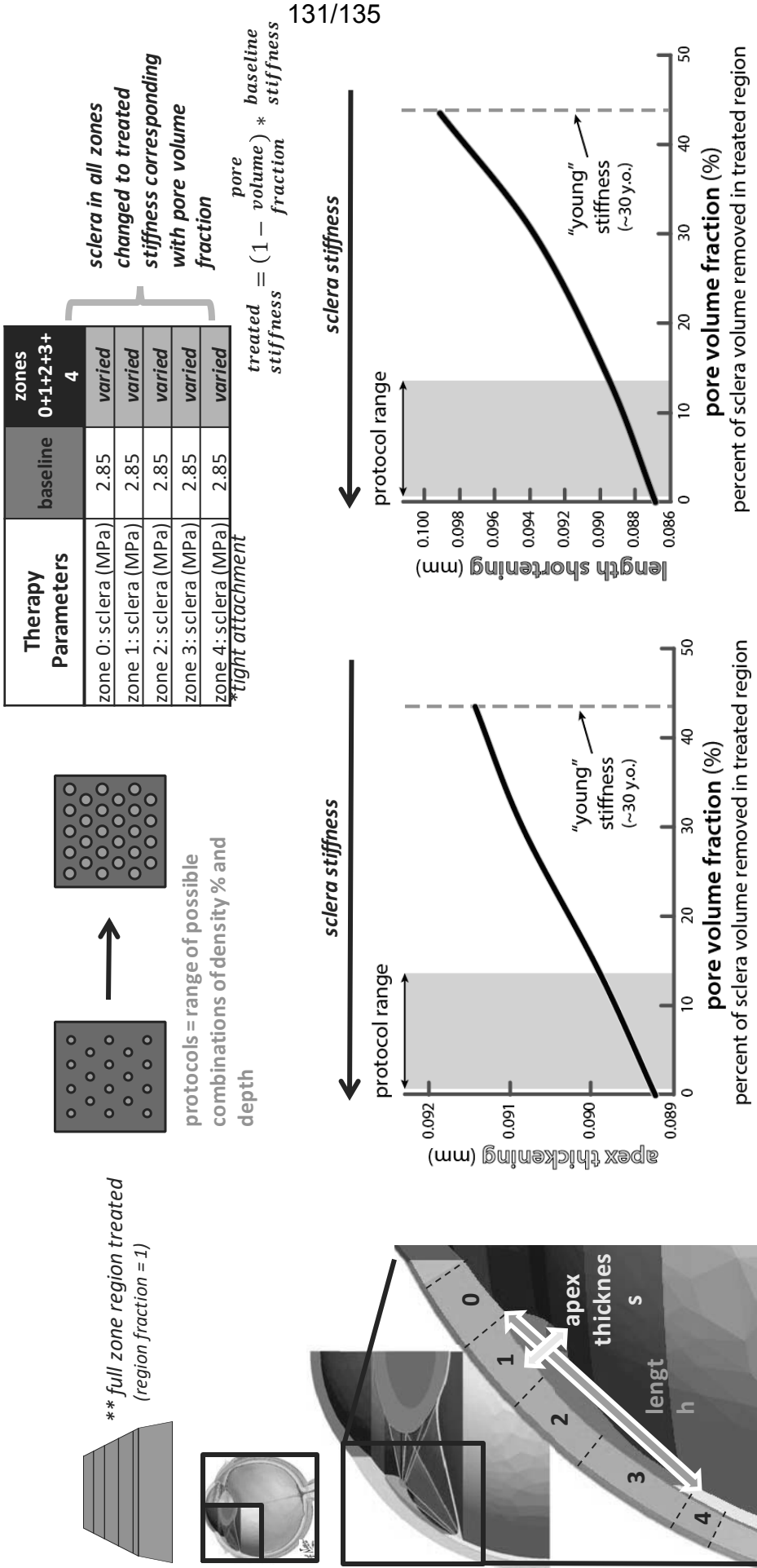


FIG. 38

effect of volume fraction on ciliary deformation in accommodation:
sclera stiffness + attachment

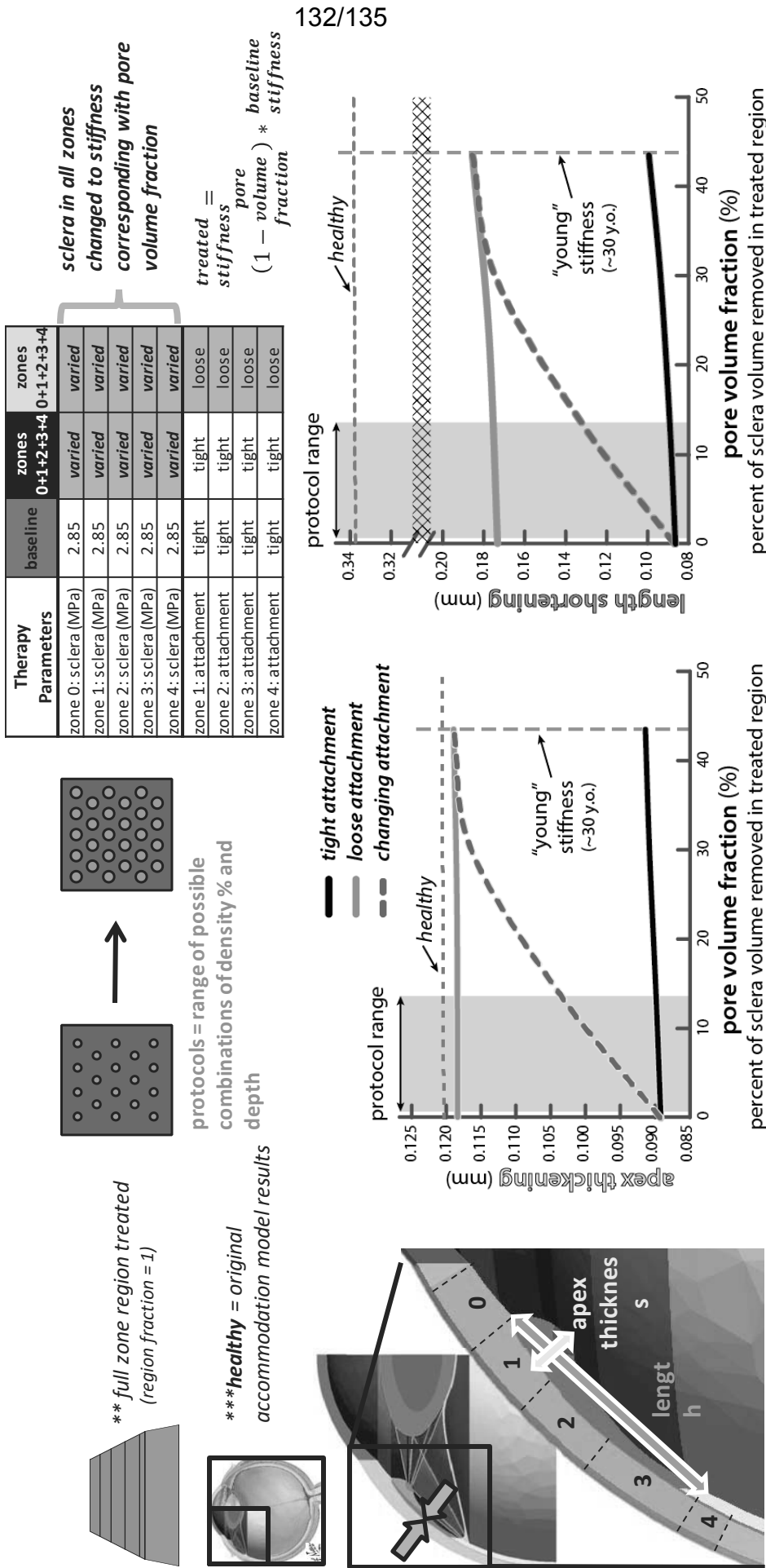
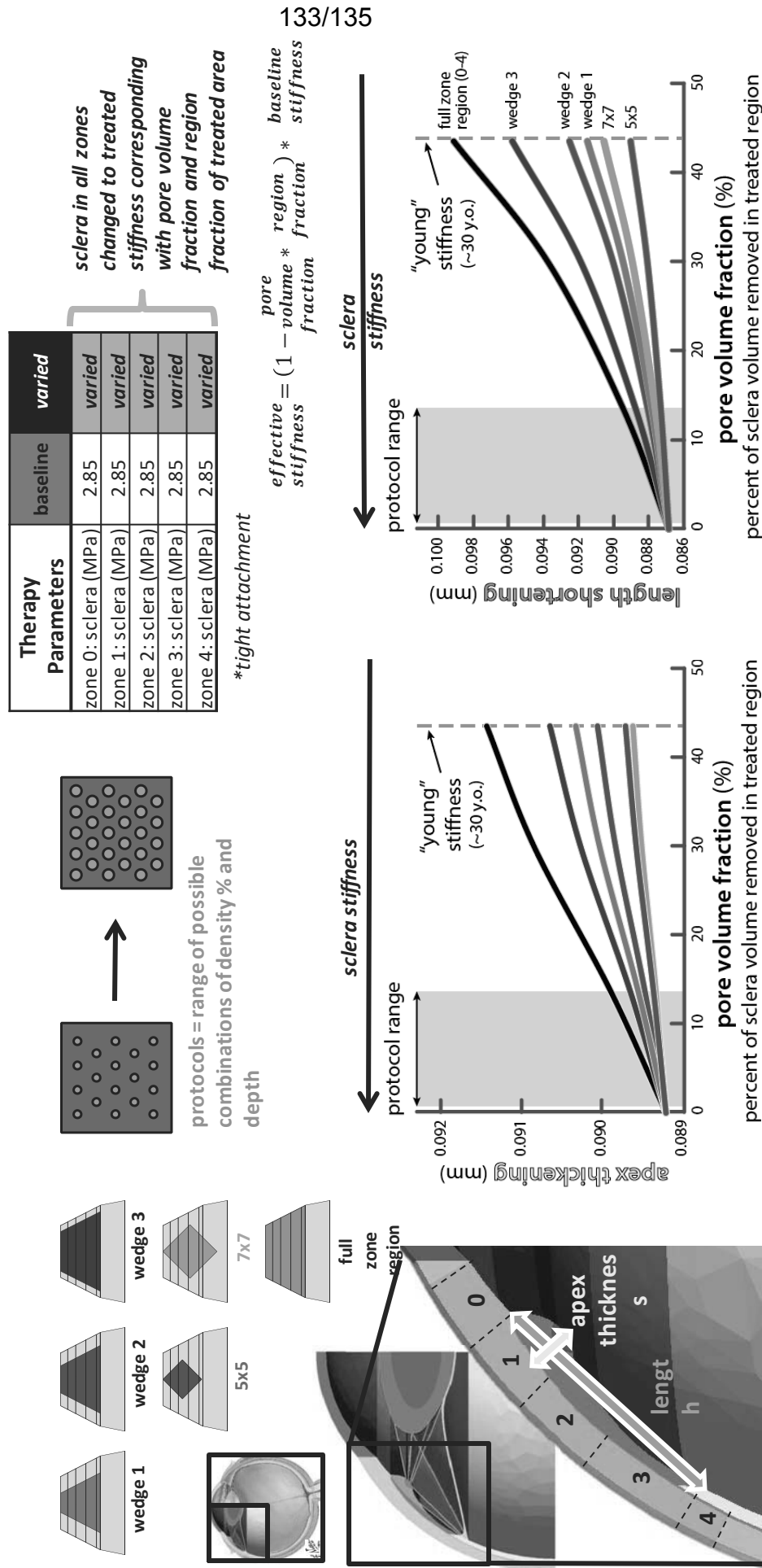


FIG. 39

effect of volume fraction on ciliary deformation in accommodation: sclera stiffness + treatment area shape



Contact /eye mask w apertures Custom Nozzle fitted to Docking Station: Nozzle
Guard Diagram onto Patch

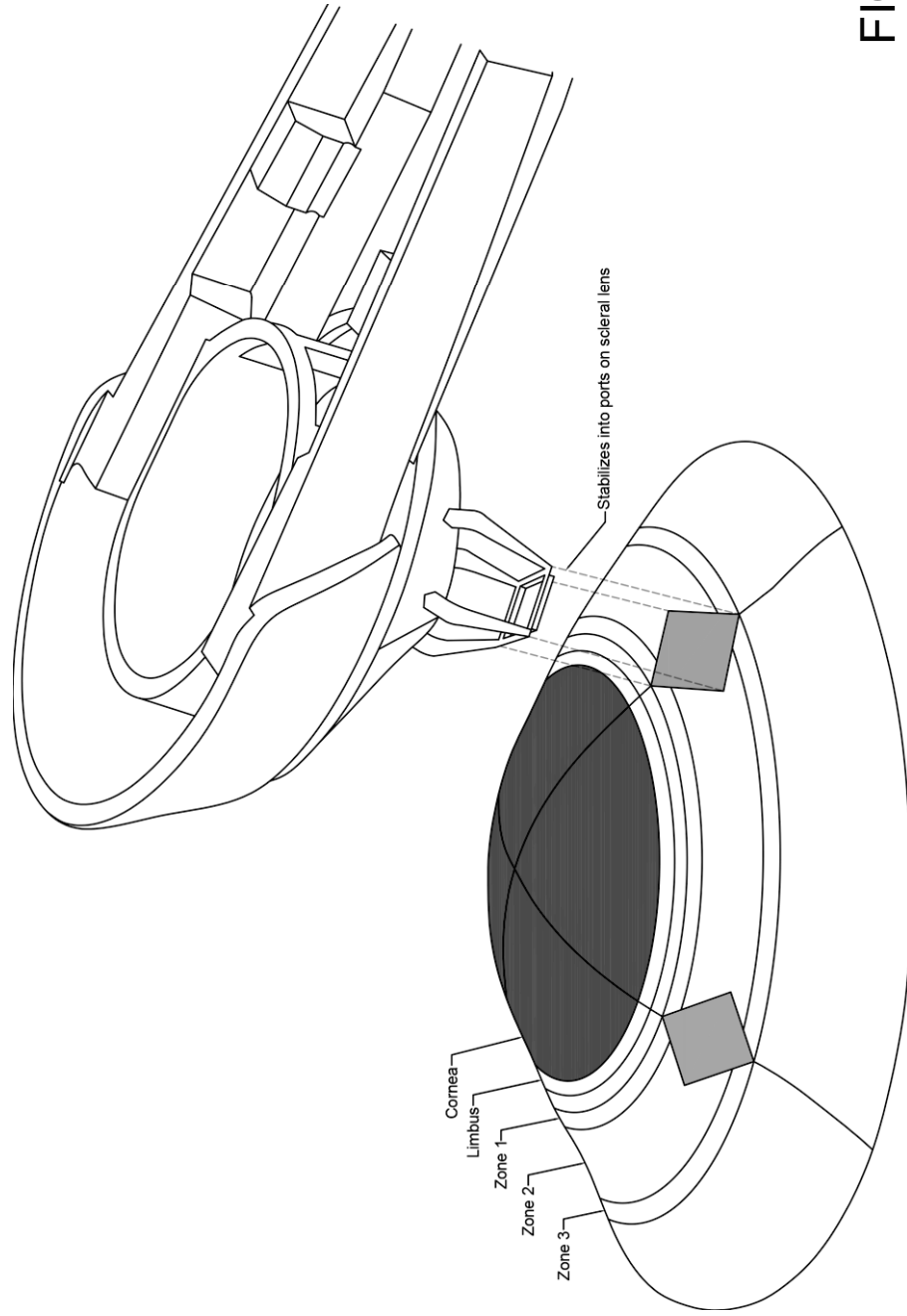


FIG. 40

Model outcomes: proposed protocol

comparison

	proposed protocol 1	proposed protocol 2	proposed protocol 3	proposed protocol 4	proposed protocol 5
treatment shape	wedge 3	wedge 2	wedge 1	7x7 array	wedge 3
density	15%	20%	30%	25%	25%
depth %	80%	80%	50%	100%	80%
spot diameter	0.225 mm	0.225 mm	0.225 mm	0.225 mm	0.225 mm
lifeform (thickness)	monkey (0.2 mm)	monkey (0.2 mm)	monkey (0.2 mm)	monkey (0.2 mm)	monkey (0.2 mm)
apex thickening (mm)	0.08962	0.08952	0.08960	0.08945	0.08962
length shortening (mm)	0.08831	0.08817	0.08784	0.08839	0.08831
accommodation recovery (%)	13.95	11.31	11.94	10.48	24.57
accommodation (D)	1.116	0.905	0.955	0.838	1.966

FIG.41