SOLID STATE Lasik

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Future in sight...

SHARP SIGHT CENTRES

Dr Kamal B. Kapur

New Delhi

Basics

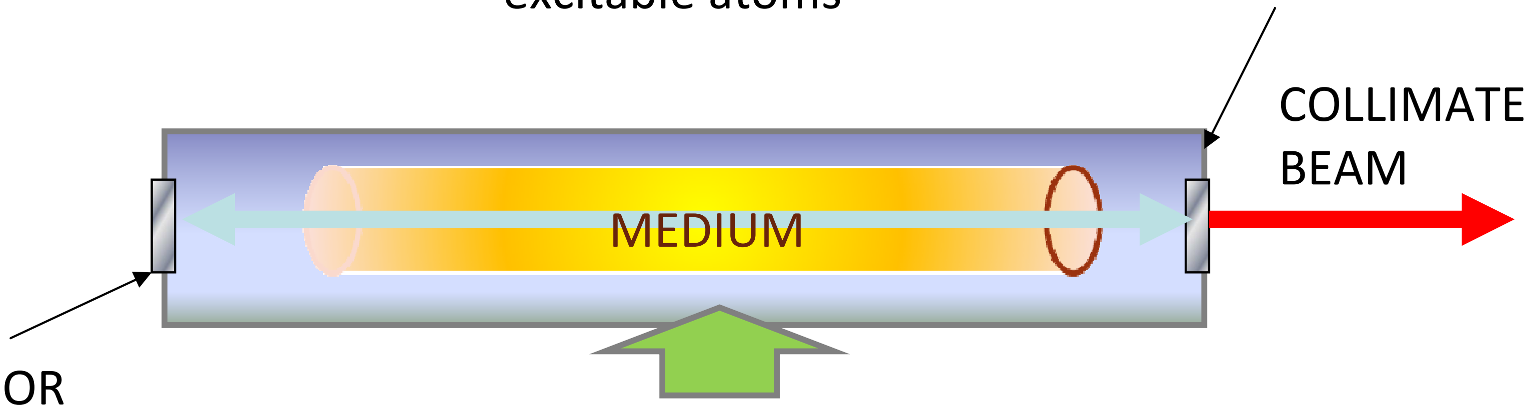
How a laser works

LASER – light amplification by stimulated emission of radiation

Contains the
excitable atoms

PARTIALLY REFLECTING
MIRROR

COLLIMATED
BEAM



MIRROR

PUMP

Energy source to
energize the atoms

CAVITY

Consists of mirrors that
allow amplification of
light to useful levels

Laser classified according to medium

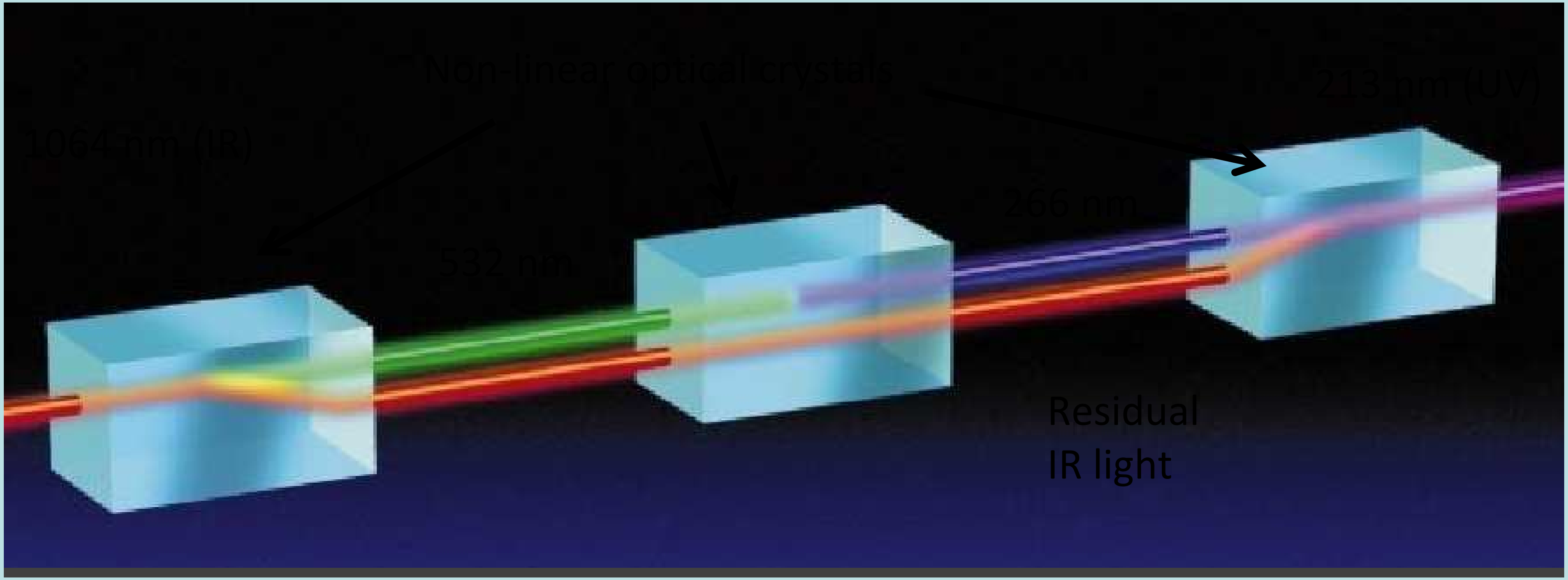
– Gas: CO2, ArF (excimer), argon, HeNe

– Liquid: organic dye laser (rhodamine)

– Solid: Ruby, Nd-YAG, Ti: Sapphire, diode

Solid State Laser Source

- Diode-pumped Nd:YAG laser



- Energy efficient; does not require high voltage; requires lower maintenance

Laser ablation of corneal tissue

Window of ablation: 190 nm to 220 nm

Wavelength range wherein photo-ablation of corneal tissue can occur with a high degree of precision and minimal collateral and thermal damage.

Excimer (Gas): 193 nm

Nd:YAG - NLO (Solid): 213 nm

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The CustomVis Pulzar Z1 Laser

•Solid state 213 nm laser

•300 Hz, 0.6 mm gaussian *flying spot (one of the smallest)*

•Ultra fast, solid state scanning,

- "crystalscan
- 1,000 hz closed loop eye tracking
  - Limbus based
  - 1 ms latency

•Gaze tracking

•Topo and WF guided treatments(both)

•Optimized asphericity standard ablation software

•Convenient "planning software to laser link " for customized treatment

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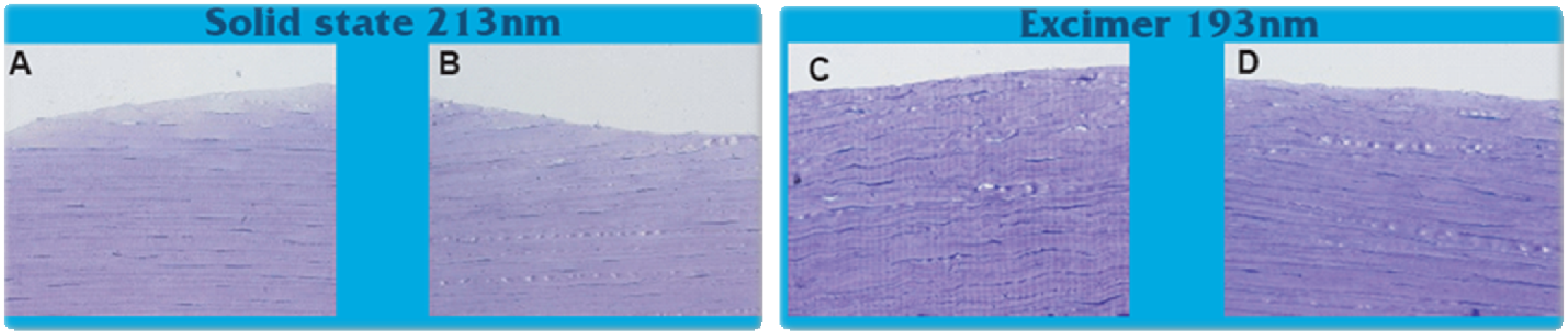
Comparison between the 213 nm (solid state) and the 193 nm (excimer) laser

Histopathological characteristics

Comparison of corneal ablation between 213 nm (solid state) and 193 nm (excimer)

In vitro using porcine corneas



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Comparison of histological characteristics

- Limited collateral damage to surrounding tissues seen in both 193 nm and 213 nm laser (Vetrugno et.al, 2001)

- Collagen lamellae remain well organized (after treatment) with both lasers (Gailitis et.al, 1991, Ren et.al 1990 jcrs)

- The amount of keratocyte apoptosis (precursor to haze) is similar between the 213 nm and the 193 nm laser.

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Histological characteristics

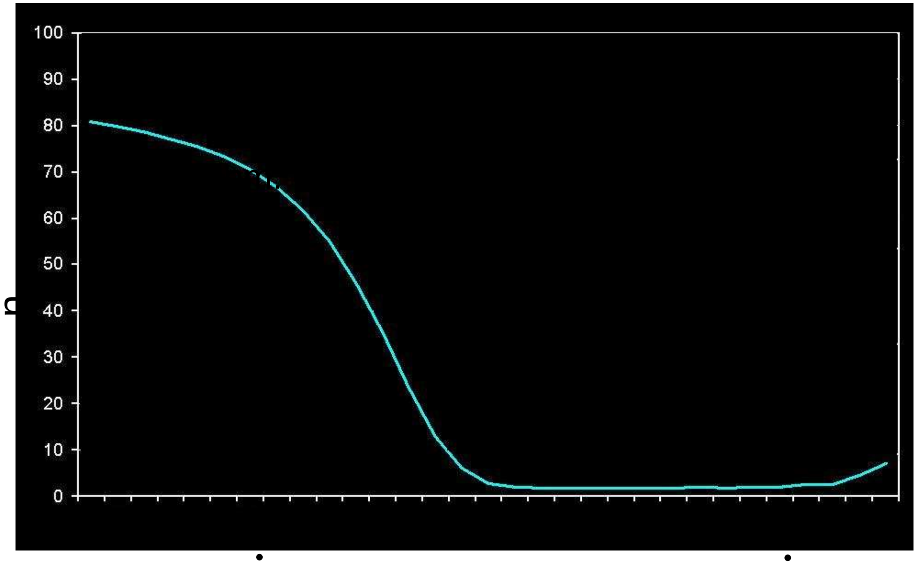
- Cell migration and proliferation is less after corneal ablation with the 213 nm (solid state)as compared to the 193 nm (excimer) laser suggesting less inflammation.

- Pseudomembrane depths of less than 1 um seen in both 193 nm and 213 nm laser ablations (Ren et.al,1990; Gailitis et.al, 1991,Caughey et.al, 1994, Campos et.al, 1990, Fantes et.al, 1989, Trokel et.al, 1983, Puliafito et.al, 1985, Marshall et.al, 1986)

Transmission through BSS and 0.9% NaCl

(Jain et al., 2004; unpublished data)

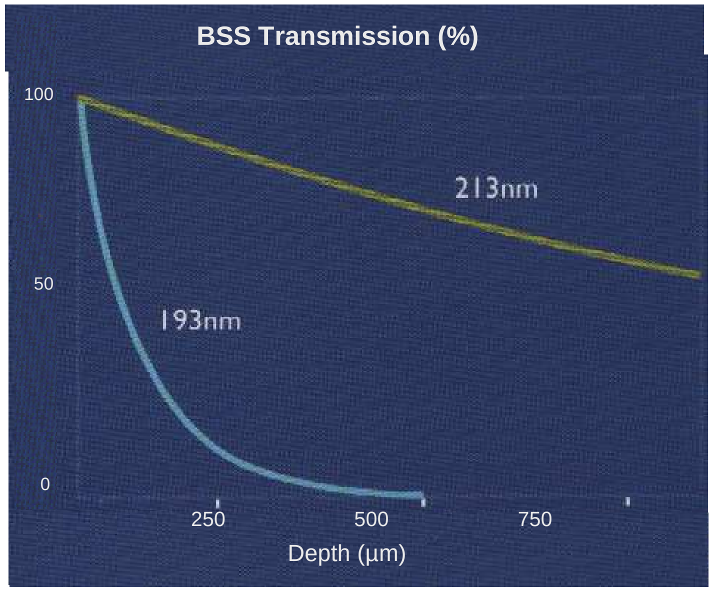
%Transmission



UV Wavelengths (220nm – 190nm)

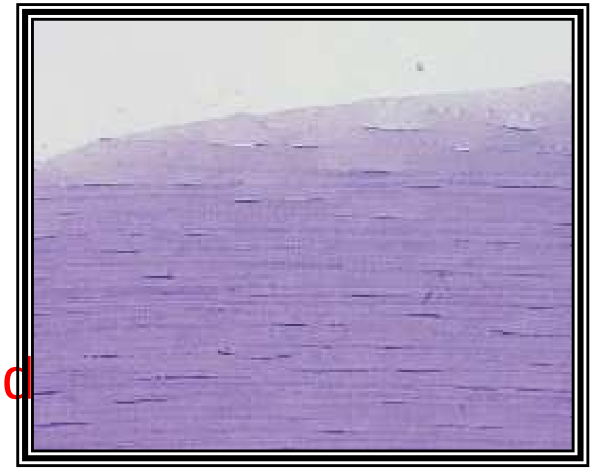
213nm has a significantly higher transmission through 0.9% NaCl and BSS than 193nm

Tissue hydration has less effect on the laser procedure with the 213 nm.



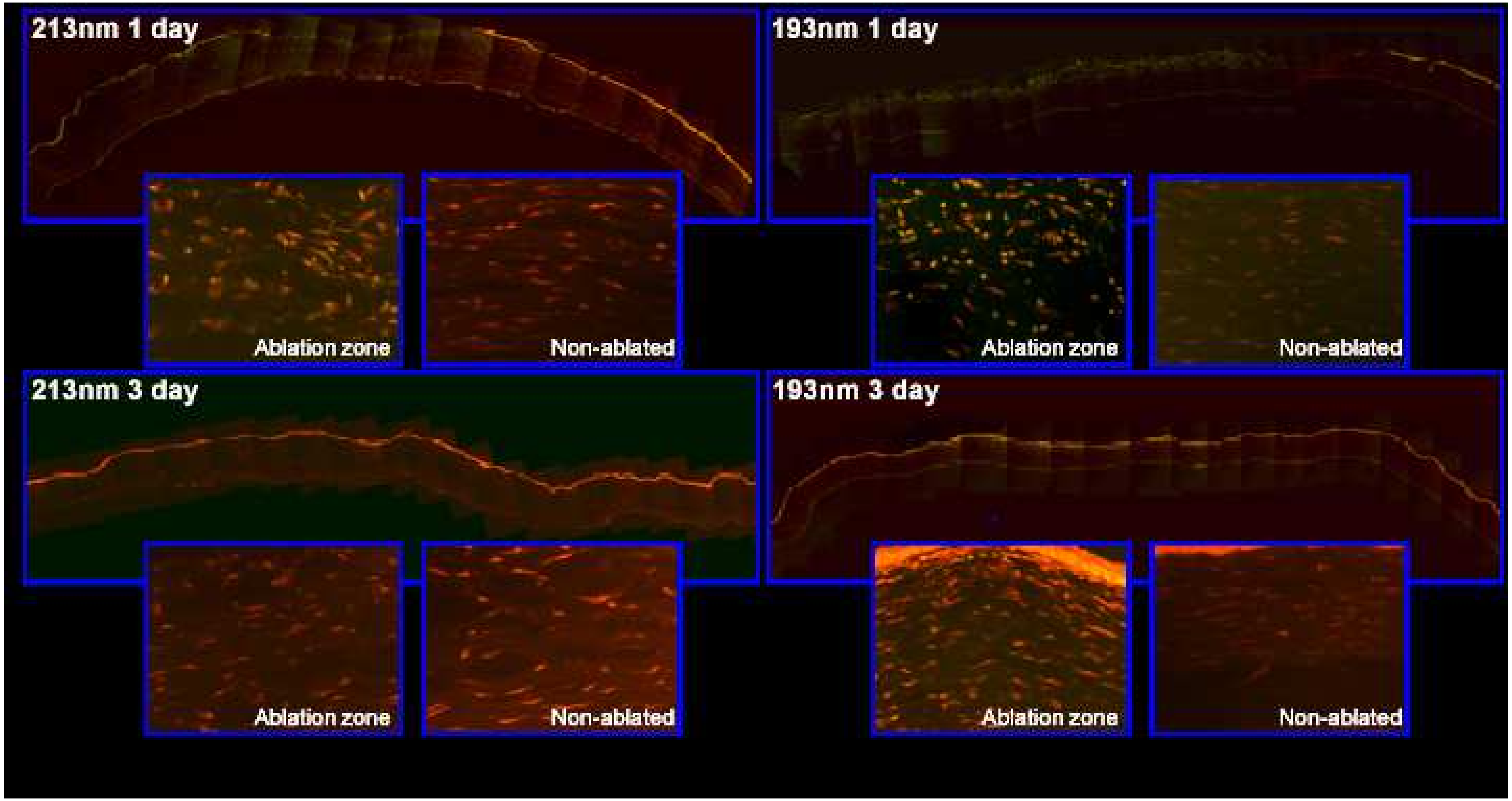
Advantages of 213nm Wavelength

- Clean & Smooth Ablated Surfaces
- Less BSS absorption than 193, hence less laser fired to achieve the same ablation depth
- Possibly Free from Hydration Monitoring (enviormental /Surgeon fudge factor)
- less laser plumes (steam) -more accuracy
- Consistent laser energy (no gas pressure maintainance)
- 213 is Closer to absorption peak of corneal collagen than 193 (less collateral damage)
- Better pulse to pulse energy stability
  "Cooler" = requires less energy to perform required corneal ablation(less energy wasted vapourize water)



SEM of 213nm ablated surface

Morphological difference bet standard laser/ Solid State



Summary of comparison

- Corneas ablated with the 213 nm and 193 nm laser show similar histological characteristics.
- The main difference is transmission through BSS and 0.9% NaCl,   213 nm > 193 nm
- Tissue hydration has less effect on the laser procedure with the 213 nm.
- 213 nm requires less energy to ablate corneal tissue.
- Studies on cytotoxicity, mutagenicity show non-conclusive findings.
- Overall benefits of the laser make it a a superior choice

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PUPIL TRACKERS-Issues

Pupil centre may shift with the change in pupillary size

GAZE tracking-Advantages

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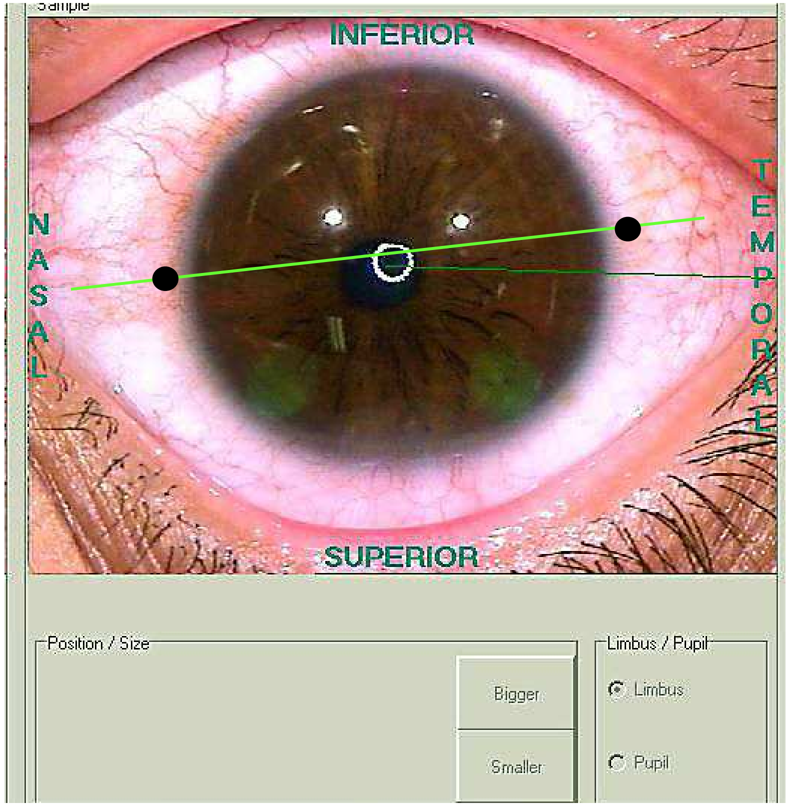

- Ablation axis is adjusted on the laser computer screen.
- According to the limbal marking points to compensate for cyclotorsion.

Axis Registration

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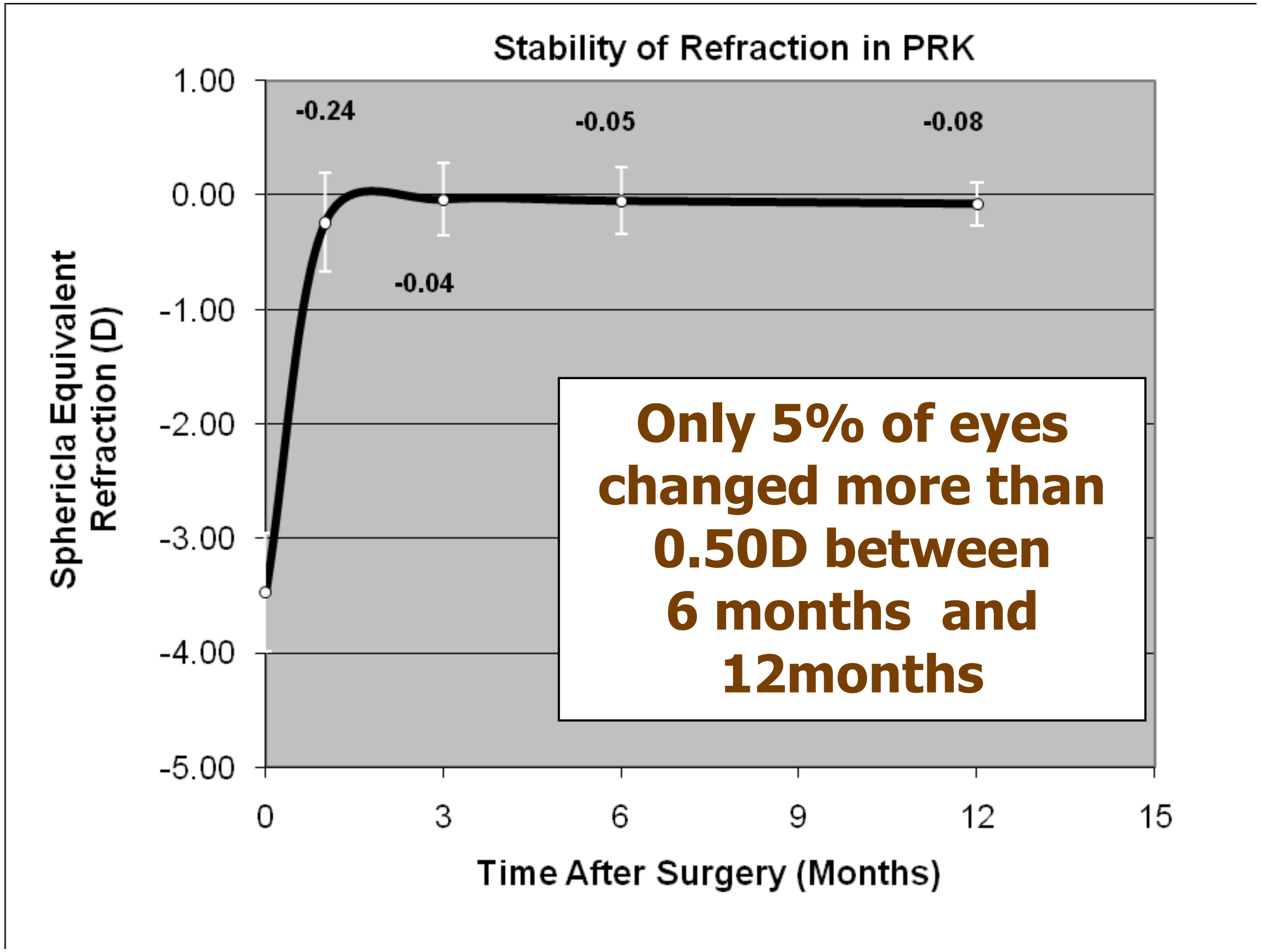
PRK Refraction Stability Results

(Published by Prof I G Pallikaris)

115 eyes with 12 months follow up



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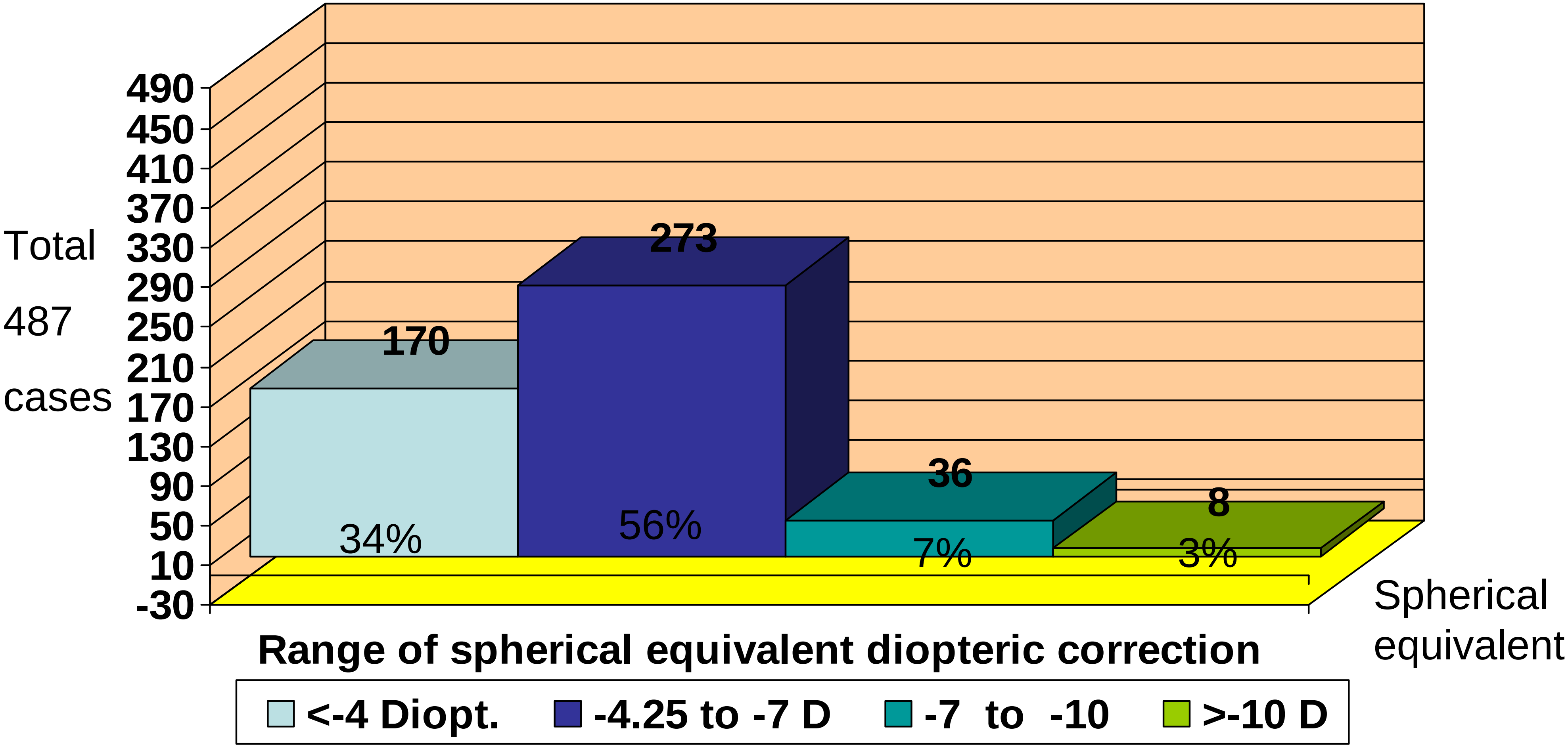
Case distribution according to Power in 487 eyes

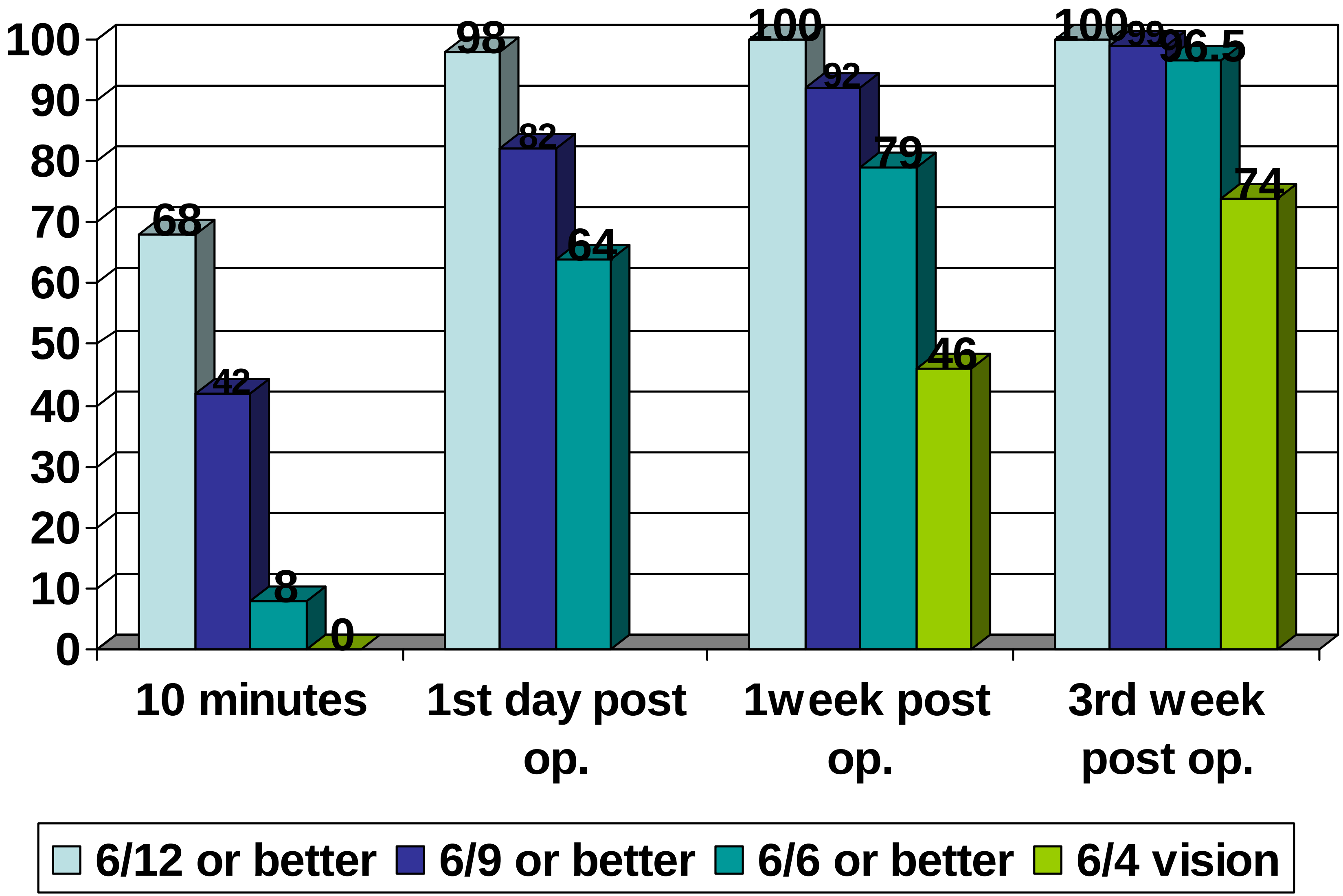


Cases from Dec 2007 till june 2008 operated at SHARP SIGHT CENTRES

Speed of visual recovery

- The best part about this laser as it is a non dehydrating laser, is the speed of visual recovery *(the corneal bed is not dehydrated)*
- The patients report significant visual improvement within 10 minutes with 68% cases improving to 6/12 and above and improving rapidly over 2-3hours to reach nearly 98% on first day post op.

Speed of visual recovery



Visual quality is extremely good

- Post Op. visual quality is excellent with fantastic high order abberation control and excellent Retinal spot diagrams along with improvement in point spread function even in non customized lasik surgery (fig1.)

- No reported glare or haloes as may be seen with some excimer lasers

- Excellent modular transfer functions are noticed even in non customized lasik (fig 2.)

Giving immense satisfaction level to all our patients

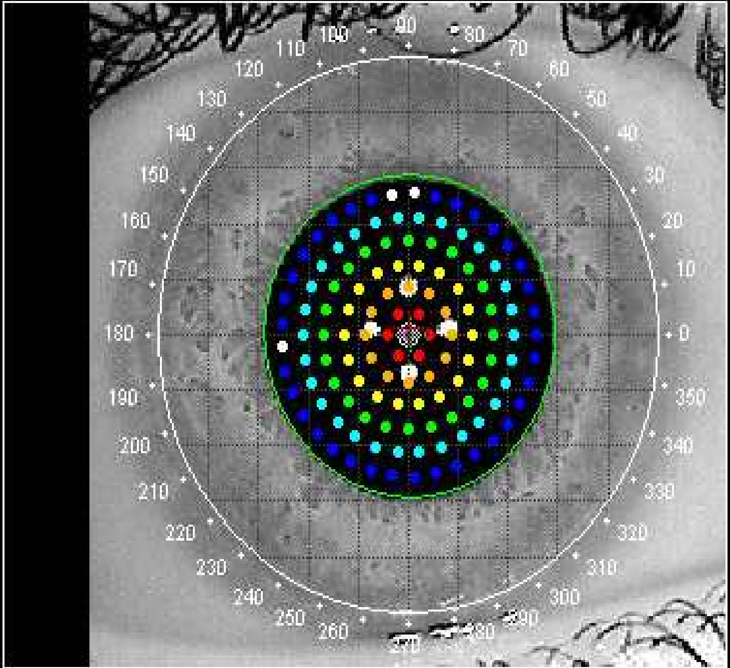
WF Verification Display
Point 1

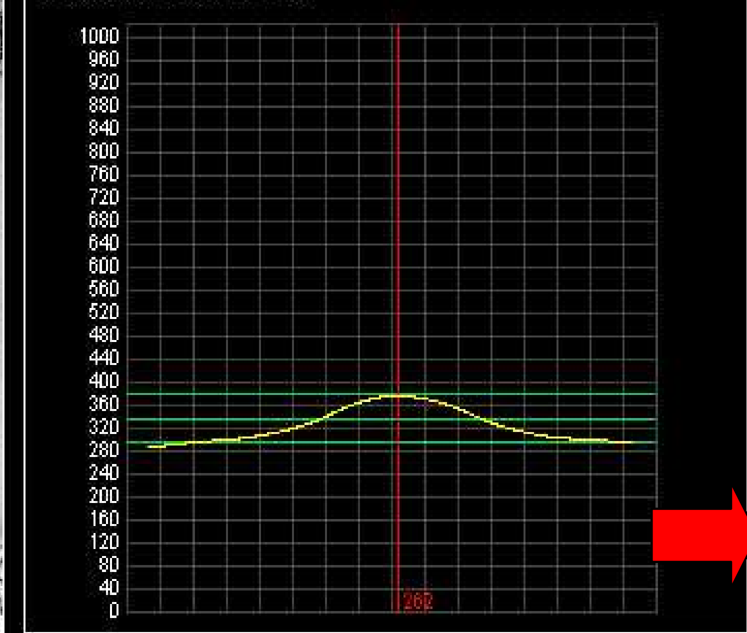
iTrace by TRACEY TECHNOLOGIES

anju yadav

Group: sharp sight centre

Horizontal Point Profile





WF Exam #1	OD
Date / Time	06-25-2008 / 16:15:23
Clinic	
Physician	
Operator	
Points Accepted / Rejected	228 / 28
Pupil / Scan Diameter	5.80 / 5.10 mm
Fixation Target Position	- 3.75 D

Auto Refraction

-8.87 D	-1.50 D	x	7°

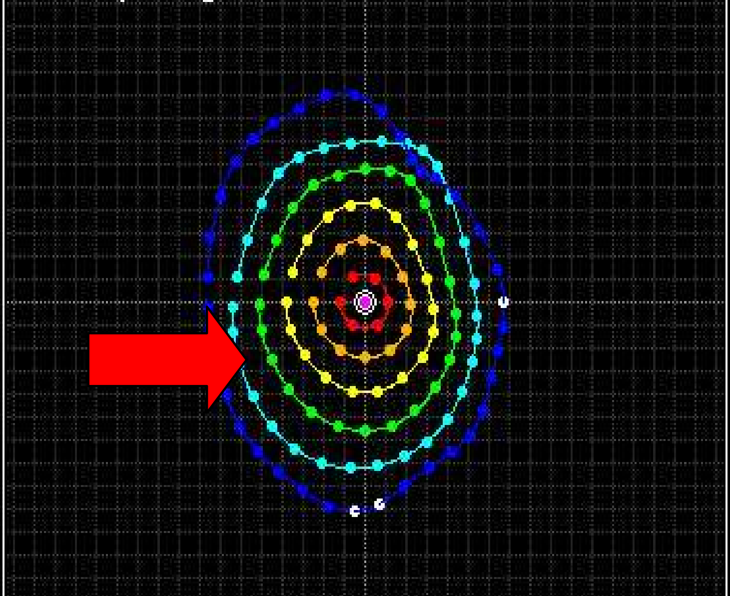
Refraction (Vertex Distance = 14.0 mm)

-8.73 D	-1.08 D	x	13°	@ 3.00 mm
-8.86 D	-1.61 D	x	5°	@ 4.50 mm
-8.88 D	-1.75 D	x	4°	@ 5.10 mm

RMS @ 5.10 mm

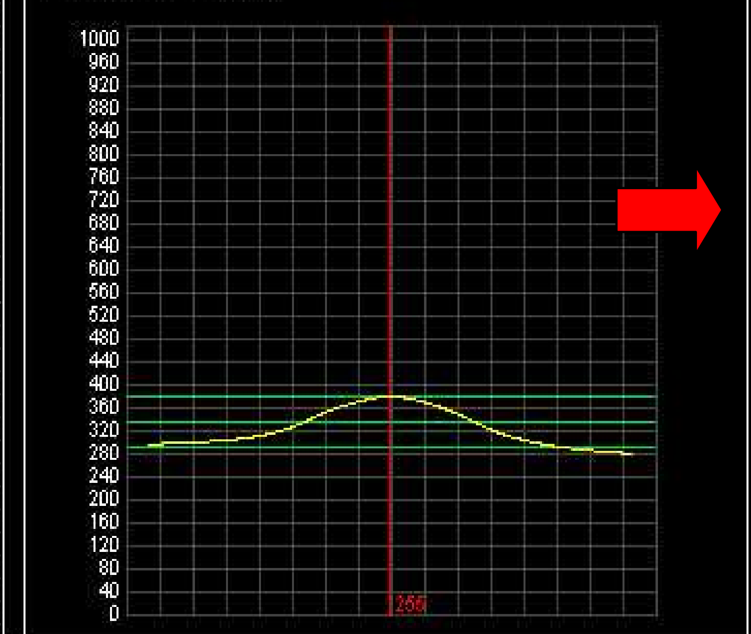
Total	8.109 μ		
LO Total	8.098 μ		
Defocus	8.049 μ		
Astigmatism	0.897 μ	x	94°
HO Total	0.423 μ		
Coma	0.172 μ	x	10°
Spherical	0.091 μ		
Trefoil	0.269 μ	x	20°

Retinal Spot Diagram

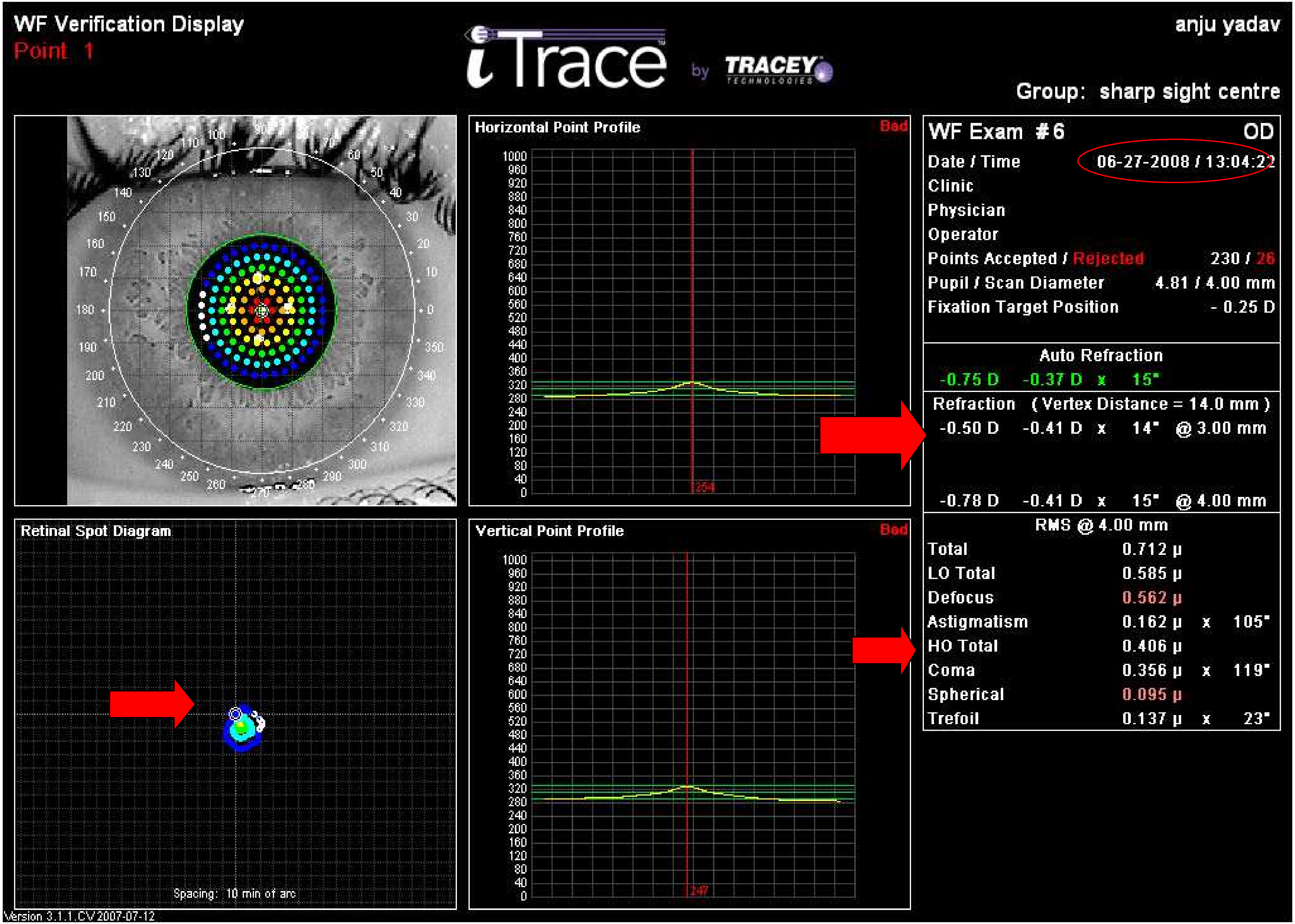


Spacing: 10 min of arc

Vertical Point Profile



Version 3.1.1.CV 2007-07-12


WF Verification Display
Point 1
iTrace by TRACEY TECHNOLOGIES
anju yadav
Group: sharp sight centre
Horizontal Point Profile
Bad
1254
Vertical Point Profile
Bad
1247
Retinal Spot Diagram
Spacing: 10 min of arc
WF Exam #6 OD
Date / Time 06-27-2008 / 13:04:22
Clinic
Physician
Operator
Points Accepted / Rejected 230 / 26
Pupil / Scan Diameter 4.81 / 4.00 mm
Fixation Target Position - 0.25 D
Auto Refraction
-0.75 D -0.37 D x 15°
Refraction (Vertex Distance = 14.0 mm)
-0.50 D -0.41 D x 14° @ 3.00 mm
-0.78 D -0.41 D x 15° @ 4.00 mm
RMS @ 4.00 mm
Total 0.712 µ
LO Total 0.585 µ
Defocus 0.562 µ
Astigmatism 0.162 µ x 105°
HO Total 0.406 µ
Coma 0.356 µ x 119°
Spherical 0.095 µ
Trefoil 0.137 µ x 23°
Version 3.1.1.CV 2007-07-12

WF Summary Display

iTrace by TRACEY TECHNOLOGIES

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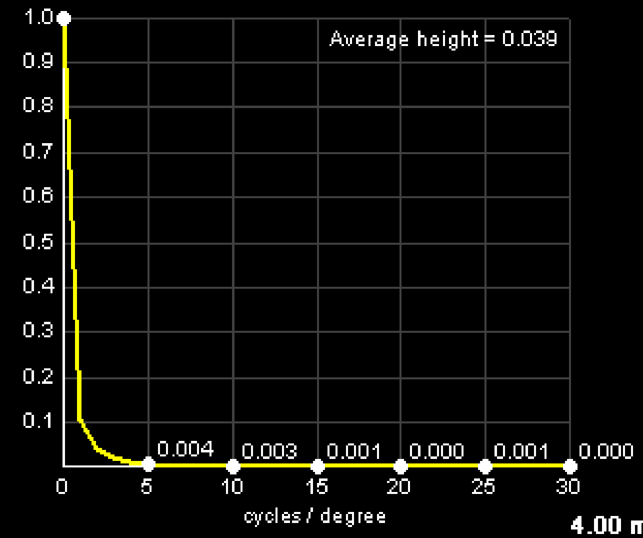
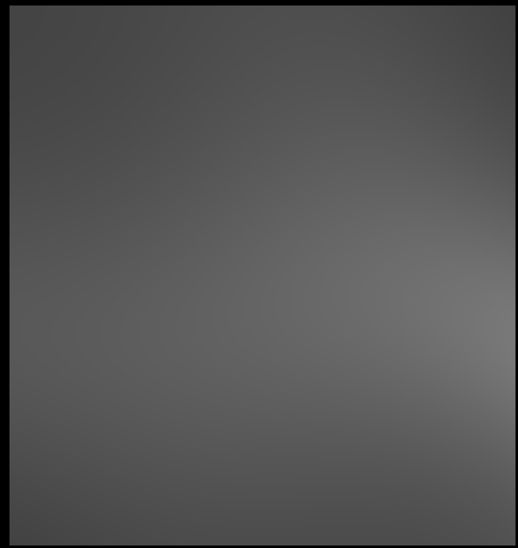
Group: sharp sight centre

Modulation Transfer Function
Total
0°



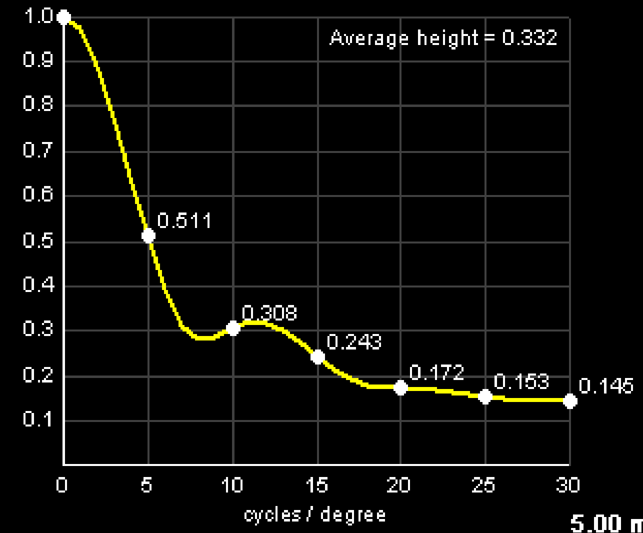
4.00 mm

Snellen Letter 20 / 40
Total



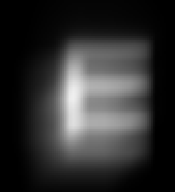
5.00 mm

Modulation Transfer Function
HO Total
0°



5.00 mm

Snellen Letter 20 / 40
HO Total



4.00 mm

WF Exam # 1 OD

Date / Time	06-25-2008 / 16:15:23
Clinic	
Physician	
Operator	
Points Accepted / Rejected	228 / 28
Pupil / Scan Diameter	5.80 / 5.10 mm
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Auto Refraction

-8.87 D -1.50 D x 7°

Refraction (Vertex Distance = 14.0 mm)

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-8.88 D	-1.75 D	x	4°	@ 5.10 mm

RMS @ 5.10 mm

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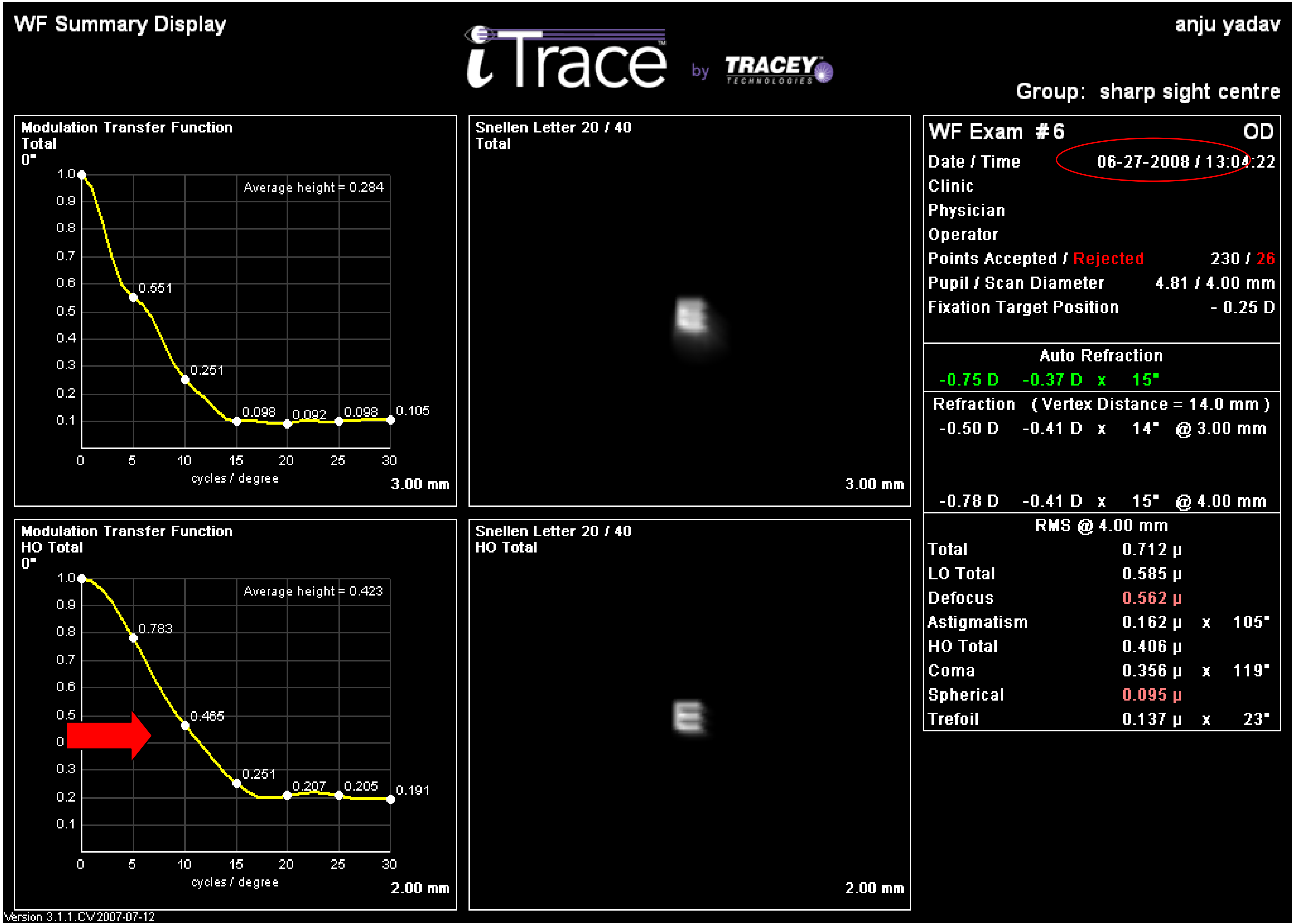
Defocus	8.049 µ		
Astigmatism	0.897 µ	x	94°
HO Total	0.423 µ		
Coma	0.172 µ	x	10°
Spherical	0.091 µ		
Trefoil	0.269 µ	x	20°

Version 3.1.1.CV 2007-07-12


WF Summary Display
iTrace by TRACEY TECHNOLOGIES
anju yadav
Group: sharp sight centre
Modulation Transfer Function
Total
0°
Average height = 0.284
0.551
0.251
0.098
0.092
0.098
0.105
cycles / degree
3.00 mm
Snellen Letter 20 / 40
Total
3.00 mm
WF Exam #6 OD
Date / Time 06-27-2008 / 13:04:22
Clinic
Physician
Operator
Points Accepted / Rejected 230 / 26
Pupil / Scan Diameter 4.81 / 4.00 mm
Fixation Target Position - 0.25 D
Auto Refraction
-0.75 D -0.37 D x 15°
Refraction (Vertex Distance = 14.0 mm)
-0.50 D -0.41 D x 14° @ 3.00 mm
-0.78 D -0.41 D x 15° @ 4.00 mm
RMS @ 4.00 mm
Total 0.712 µ
LO Total 0.585 µ
Defocus 0.562 µ
Astigmatism 0.162 µ x 105°
HO Total 0.406 µ
Coma 0.356 µ x 119°
Spherical 0.095 µ
Trefoil 0.137 µ x 23°
Modulation Transfer Function
HO Total
0°
Average height = 0.423
0.783
0.465
0.251
0.207
0.205
0.191
cycles / degree
2.00 mm
Snellen Letter 20 / 40
HO Total
2.00 mm
Version 3.1.1.CV 2007-07-12

WF Summary Display

kanika rastogi

Sharp Sight Centres

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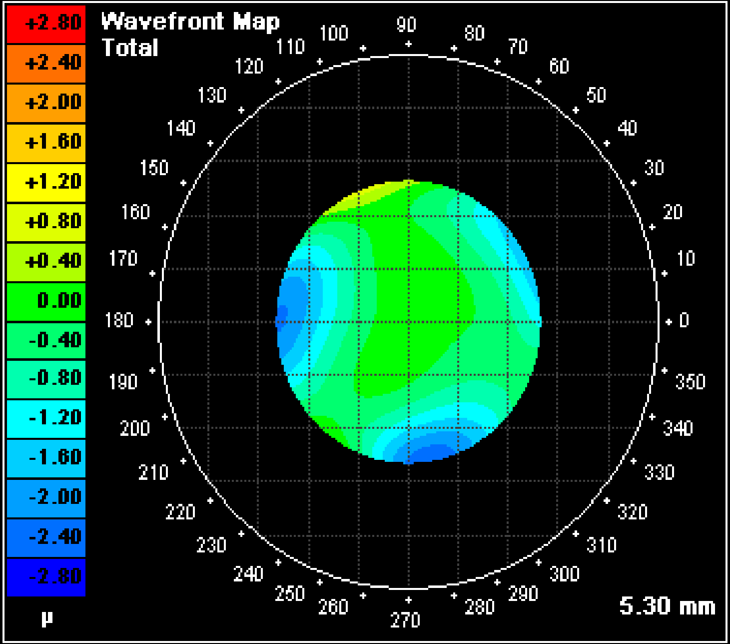
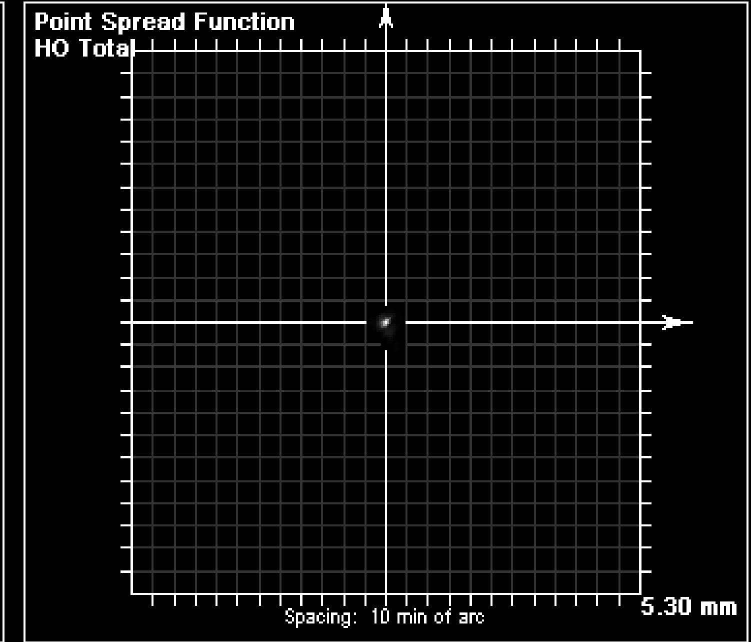




WF Exam #9 OS

Date / Time	03-25-2008 / 15:37:34
Clinic	
Physician	
Operator	
Points Accepted / Rejected	252 / 4
Pupil / Scan Diameter	6.07 / 5.30 mm
Fixation Target Position	+ 1.25 D

Auto Refraction

+0.62 D -0.37 D x 158°

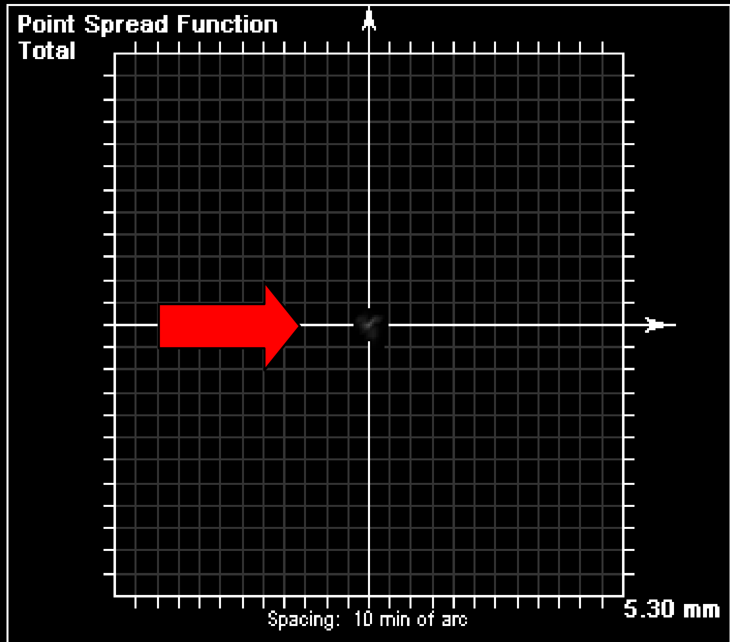
Refraction (Vertex Distance = 14.0 mm)

+0.63 D	-0.53 D	x	160°	@ 3.00 mm
+0.53 D	-0.25 D	x	161°	@ 4.50 mm
+0.42 D	-0.20 D	x	174°	@ 5.30 mm

RMS - Total

z	n	m	Name	μ
3	2	-2	Astigmatism	0.032
4	2	0	Defocus	0.329
5	2	2	Astigmatism	0.144
6	3	-3	Trefoil	0.263
7	3	-1	Coma	0.059
8	3	1	Coma	0.055
9	3	3	Trefoil	0.299
10	4	-4	Tetrafoil	0.052
11	4	-2	Astigmatism	0.078
12	4	0	Spherical	0.071
13	4	2	Astigmatism	0.009
14	4	4	Tetrafoil	0.119
15	5	-5	Pentafoil	0.017
16	5	-3	Trefoil	0.007
17	5	-1	Coma	0.002
18	5	1	Coma	0.034
19	5	3	Trefoil	0.030
20	5	5	Pentafoil	0.020
21	6	-6	Hexafoil	0.002
22	6	-4	Tetrafoil	0.013
23	6	-2	Astigmatism	0.004
24	6	0	Spherical	0.044
25	6	2	Astigmatism	0.032
26	6	4	Tetrafoil	0.005
27	6	6	Hexafoil	0.010

5.30 mm



RMS @ 5.30 mm

Total	0.574 μ		
LO Total	0.360 μ		
Defocus	0.329 μ		
Astigmatism	0.147 μ	x	84°
HO Total	0.447 μ		
Coma	0.081 μ	x	133°
Spherical	0.071 μ		
Trefoil	0.398 μ	x	106°

1st day post operative

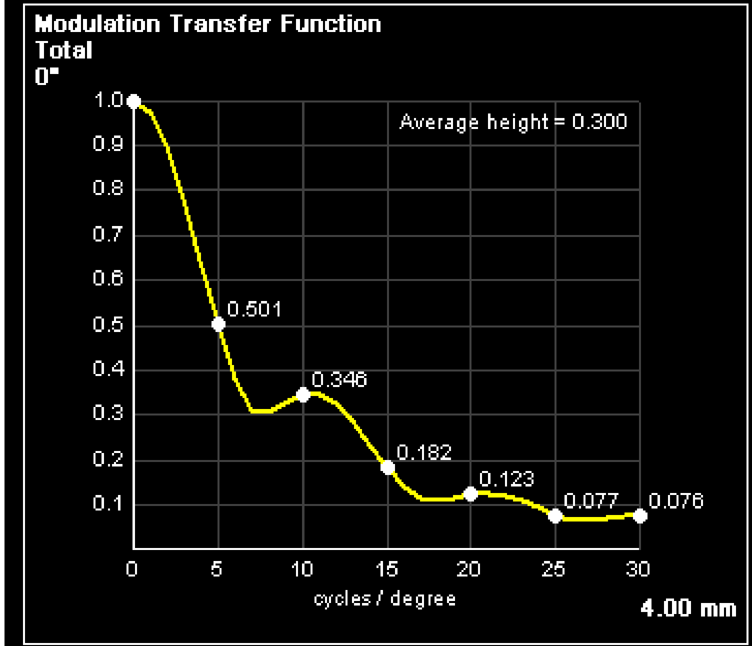
Notice- Improved point spread function

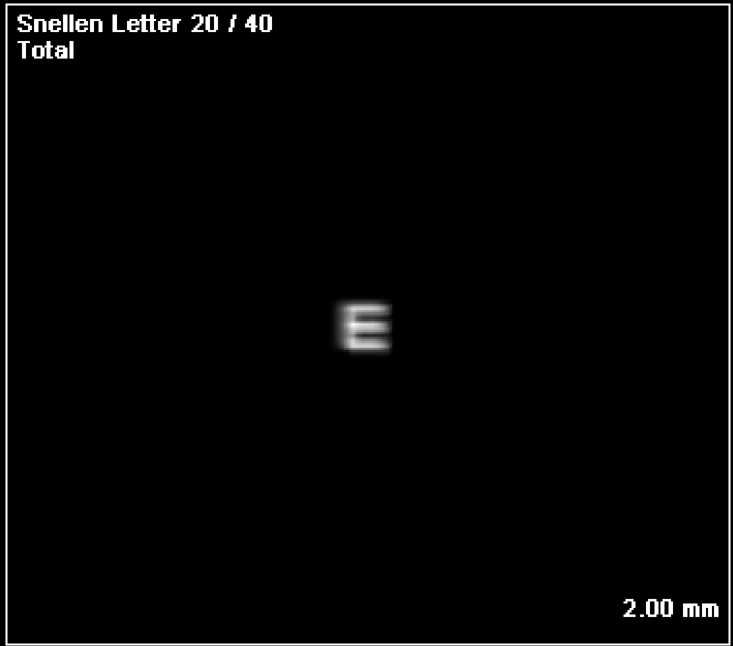
Version 3.1.1.CV 2007-07-12

WF Summary Display

kanika rastogi

Sharp Sight Centres





WF Exam #9	OS
Date / Time	03-25-2008 / 15:37:34
Clinic	
Physician	
Operator	
Points Accepted / Rejected	252 / 4
Pupil / Scan Diameter	6.07 / 5.30 mm
Fixation Target Position	+ 1.25 D

Auto Refraction

+0.62 D -0.37 D x 158°

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RMS @ 5.30 mm

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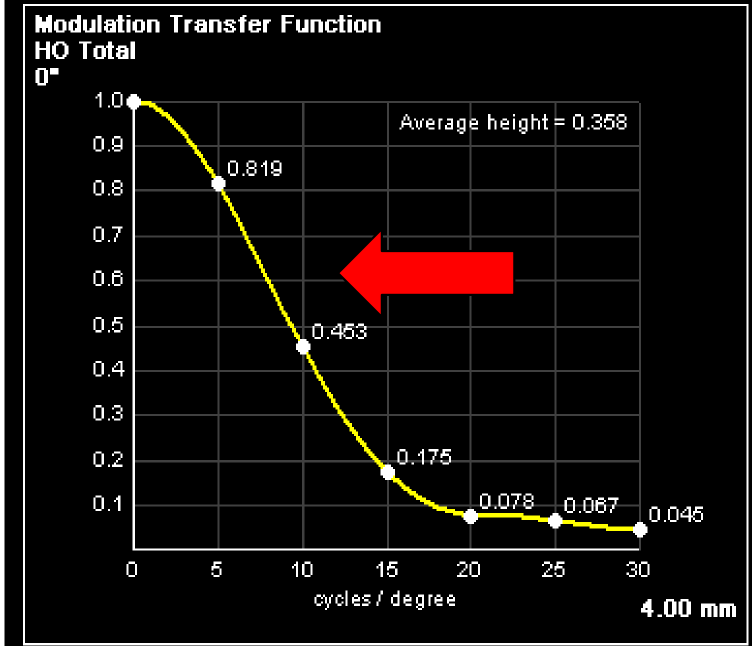
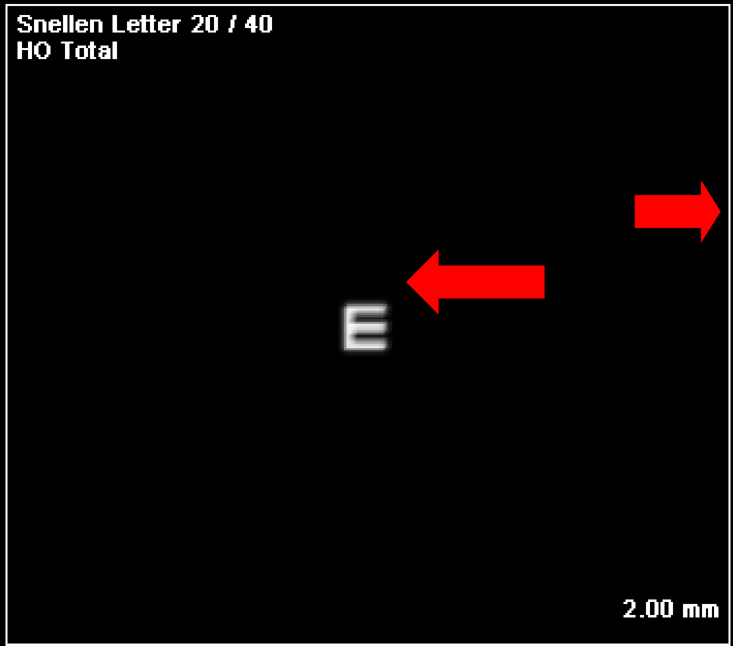
Trefoil	0.398 μ	x	106°

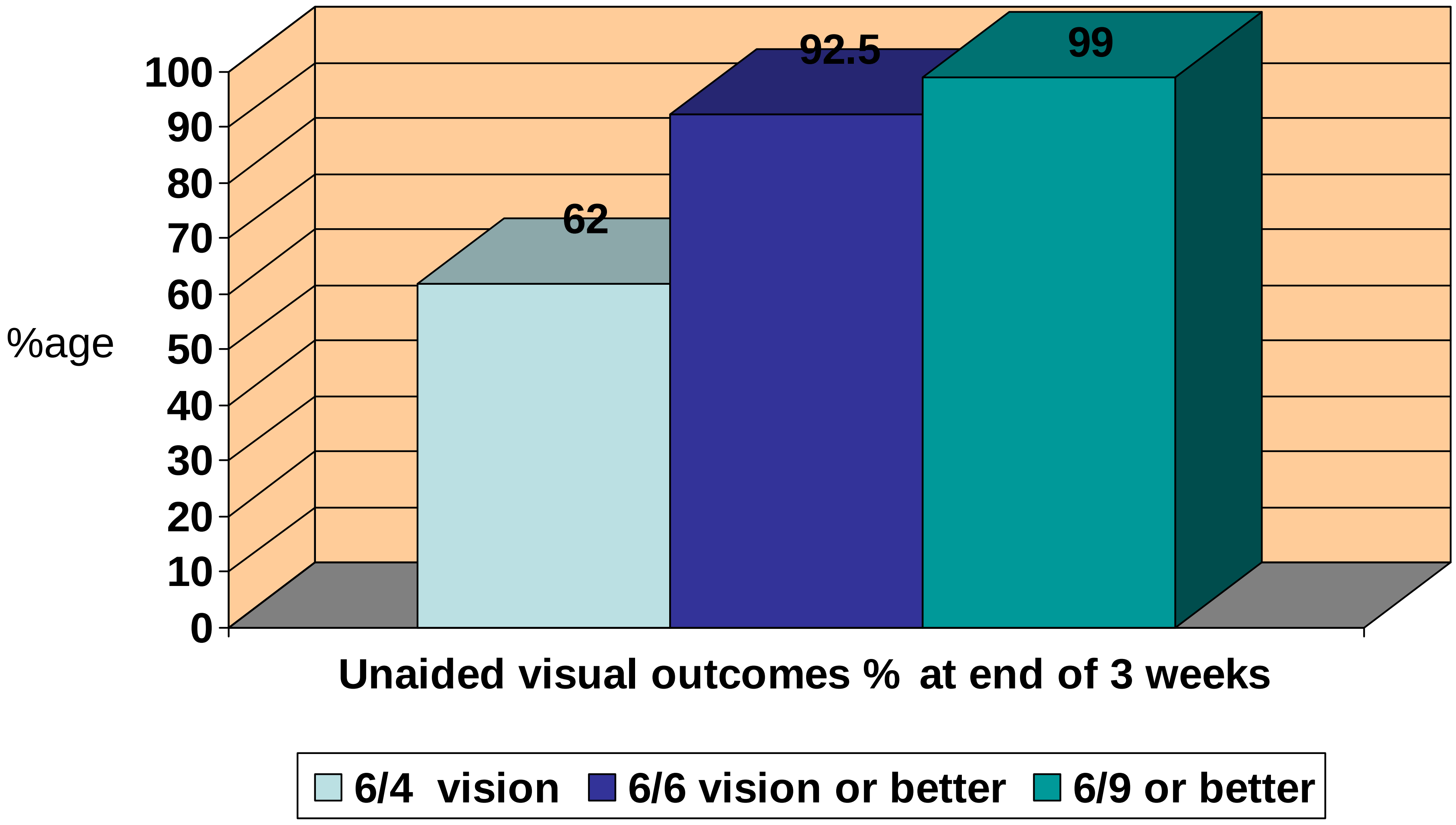




Excellent MTF values with improved snellen acuity in dark too

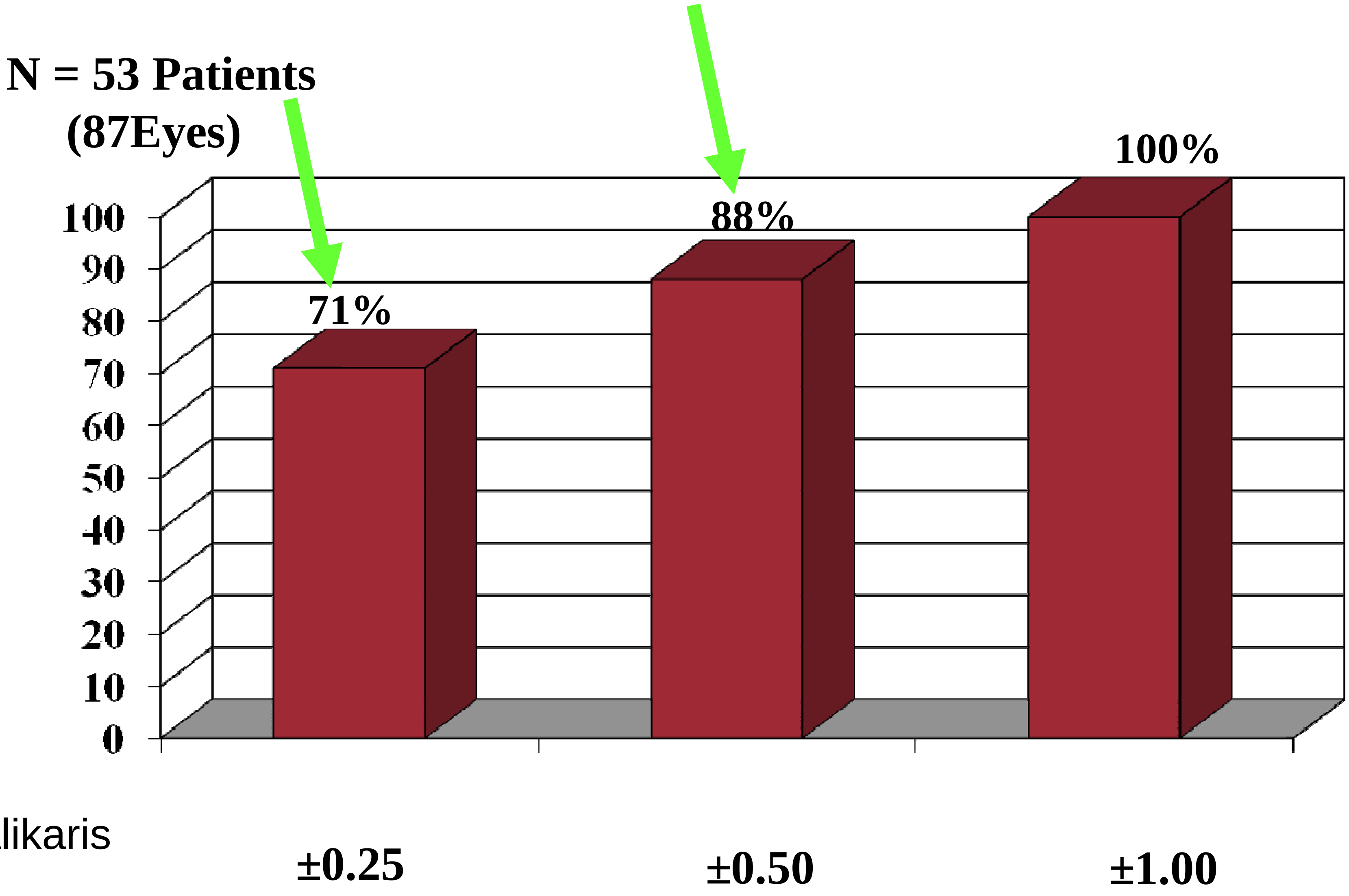
Version 3.1.1.CV 2007-07-12

Visual acuity unaided



Power range -2 to -7 d

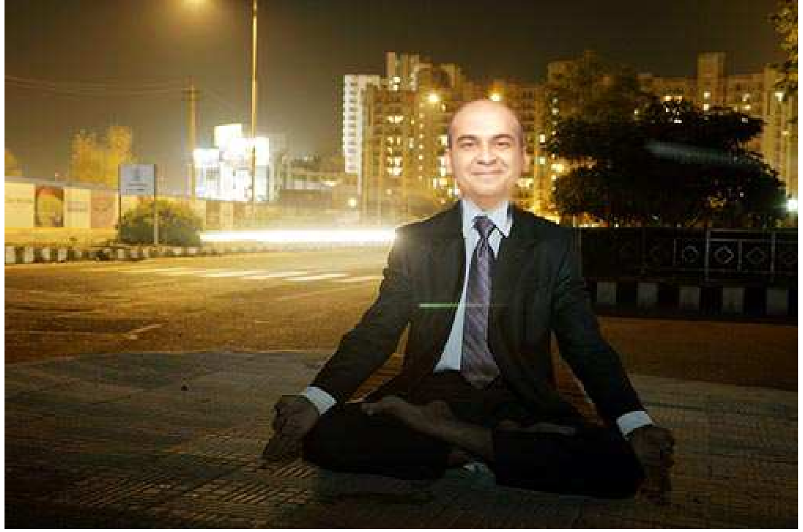
Predictability of MRSE @ 6 Months After Surgery



Dr. Palikaris

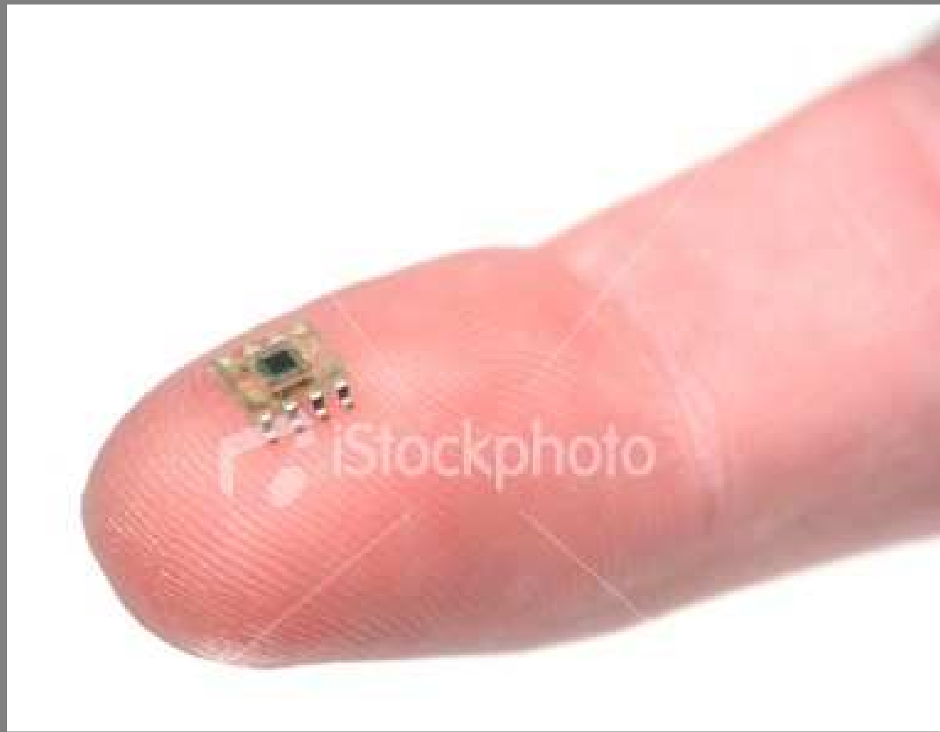
Number of patients followed up till 6 months

Practical stuff



- Small compact machine(less space)
- No restriction of surgery days
- No recurring cost of corrosive gases
- Less power consumption
- Less humidity and temp. dependent
- Hydration during procedure improves fixation
- Flaps sticks firm and faster
- Notice less flap edge haze
- PATIENTS HAPPY+DOCTOR HAPPY

Gas Filled Diode Tubes were replaced by Microchips



Just as Liquid Crystal Diode Screens (LCD) replaced gas filled TV monitors

Gas based Excimer laser will be replaced by SOLID STATE CRYSTAL BASED LASIK

No to Toxic Gases

No to Scary Noises

No to High Power Consumption

No to Hot Laser

No to Restricted Surgery Days

No to Bigger Flying Spot

No to Slow Eye Trackers

No to Longer Warm Up Time

No to Old Technology

NO TO EXCIMER LASER…..

Yes to Crystal Technology

Yes to Quiet Operation

Yes to Low Power Consumption

Yes to Cold Laser

Yes to Anytime Surgery

Yes to Smaller 0.6mm Spot

Yes to Fast (1KHz) Eye Tracker

Yes to Short Warm Up Time

Yes to The Future in Sight>>>

YES TO SOLID STATE LASER

Conclusion

- **Asphericity, centration and cyclotorsion optimization** in standard CustomVis treatments prevented any significant induction of SA and coma and probably represents **all the customization that is needed to achieve** the desired quality of vision in **myopic eyes**
- Customized ablation that aims for **treatment** of **HOAs** is probably necessary **only where such aberrations are significantly increased i.e. in symptomatic irregular astigmatism**

www.sharpsight.in