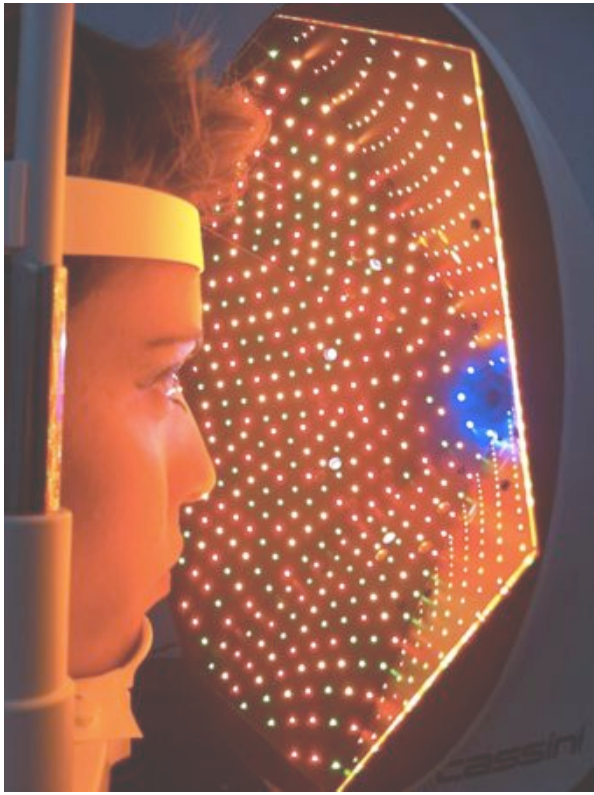
Astigmatic axis repeatability in normal, keratoconic, CXL and LASIK-treated eyes with novel multi-colored spot reflection Topography



Costas H. Karabatsas, MD, DMed, FEBO, MRCOphth, FRCS

A. John Kanellopoulos, MD

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VU topographer

Introducing color in topography

Vrije Universiteit

University

The Vrije Universiteit is a university in Amsterdam, The Netherlands. The Dutch name is often abbreviated as VU and in English the university uses the name "VU University".

Wikipedia

Enrollment: 22,738 (2009)

Founder: Abraham Kuyper

Founded: 1880

Vos FM, van der Heijde RGL, Spoelder HJW, van Stokkum IHM, Groen FCA. A new instrument to measure the shape of the cornea based on pseudorandom color coding. IEEE Trans Instrum Meas 1997;46:794–7.

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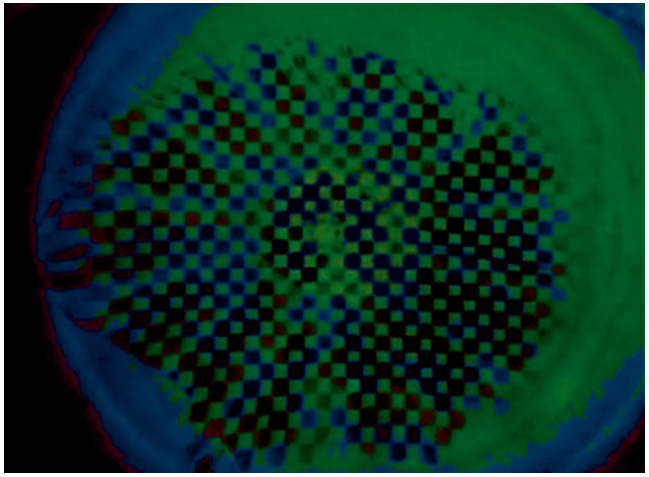
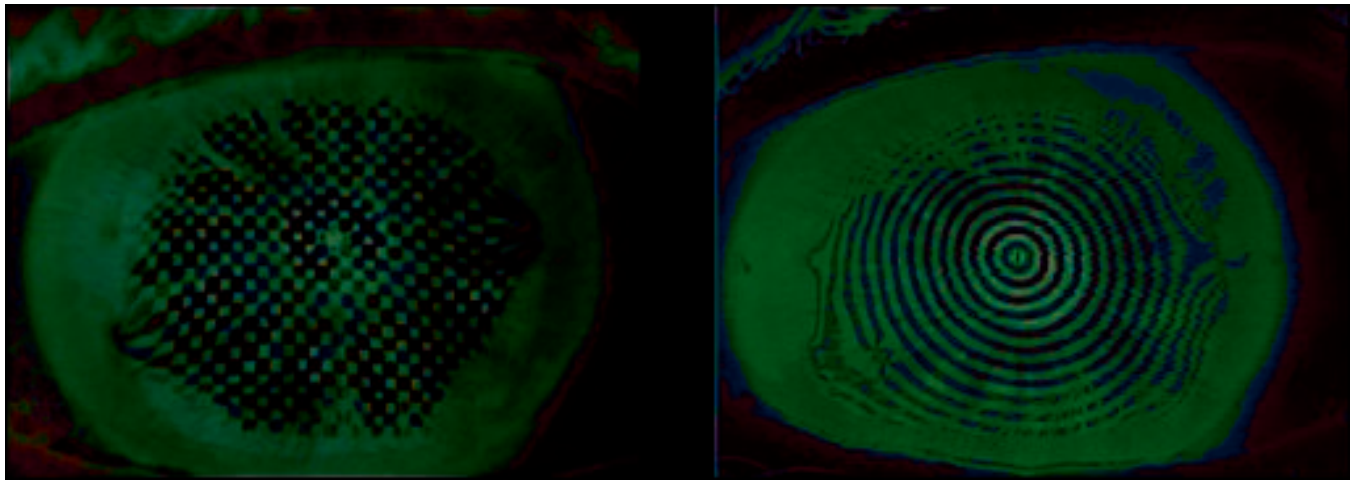
VU topographer





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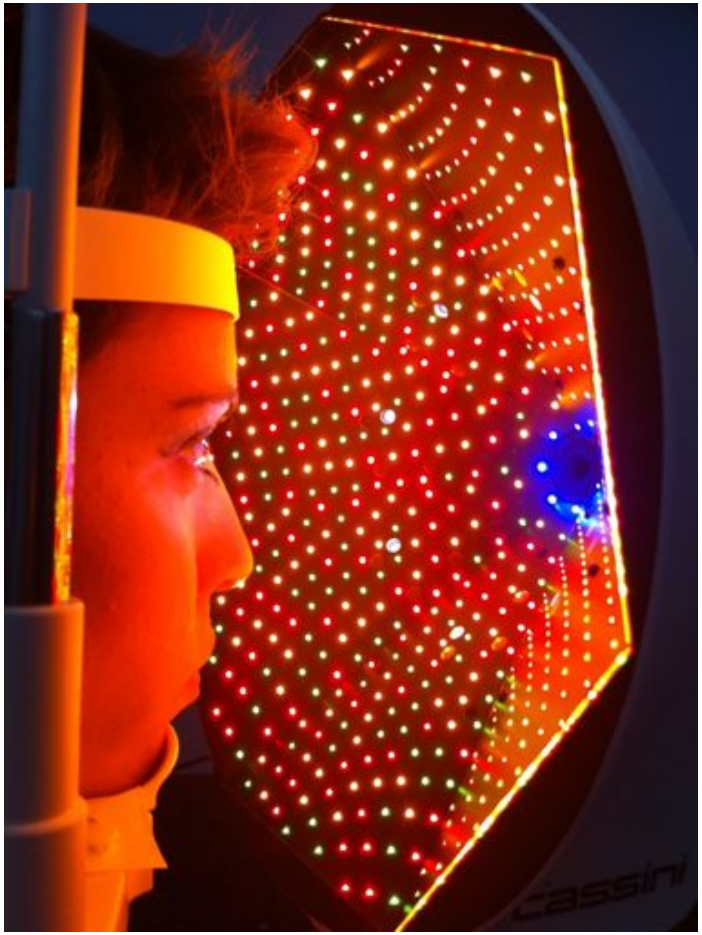
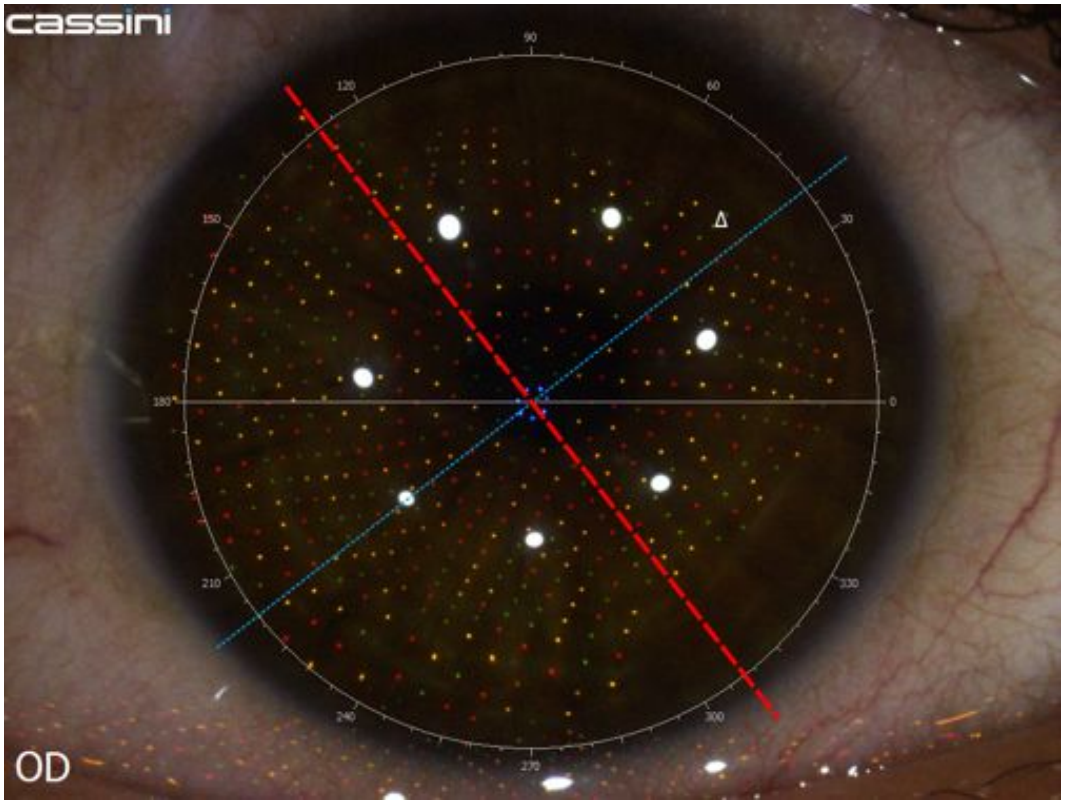
Cassini, LED corneal topographer





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Multi Colored Spot Reflection Topography: Potential Advantages

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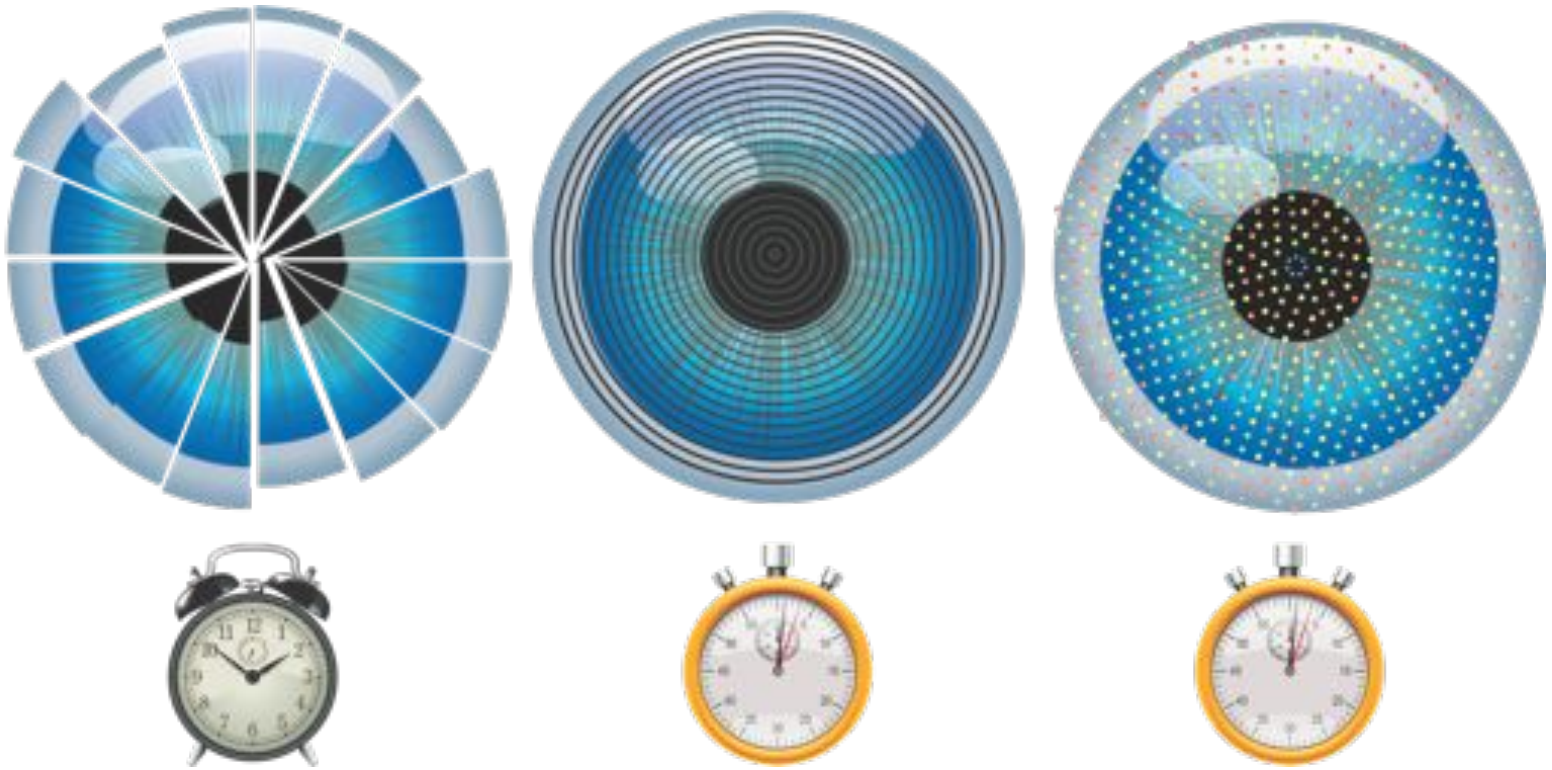
Single-shot Acquisition



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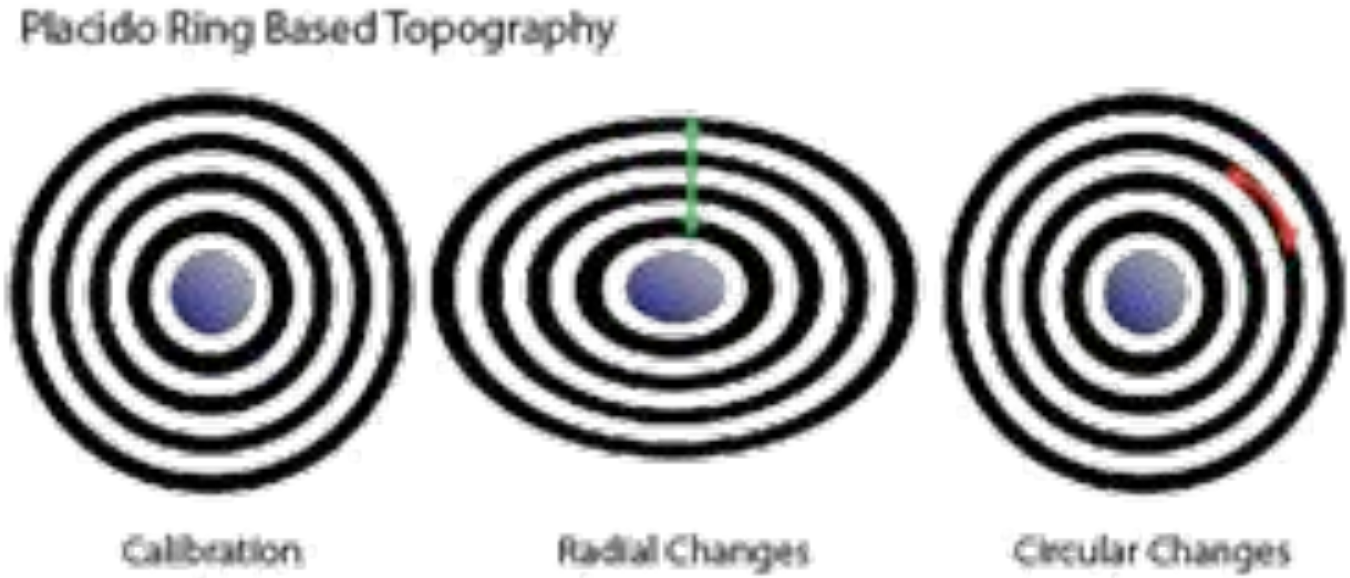
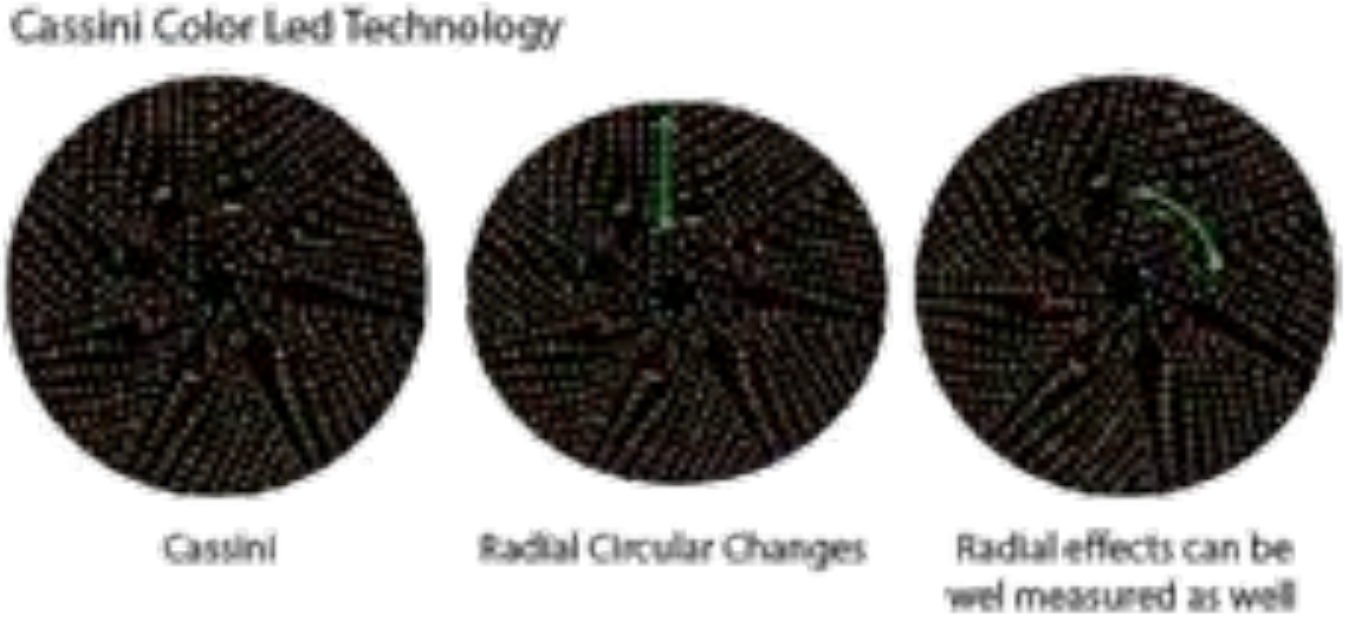
Cassini vs Placido



Ring pattern may not discern feature changes along the tangential direction.

Cassini vs Placido



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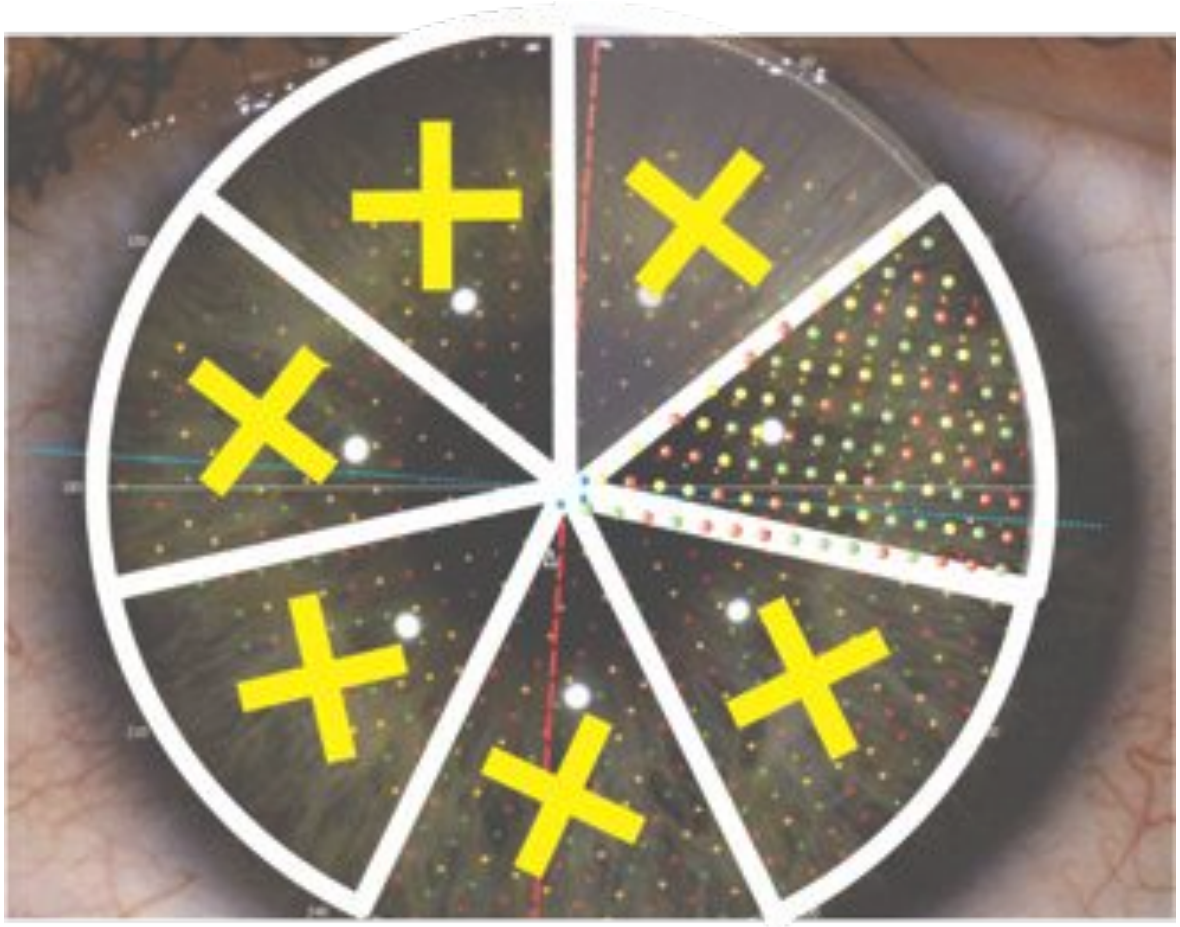
Breaking the Symmetry



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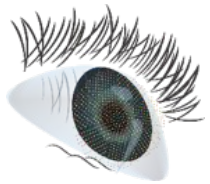
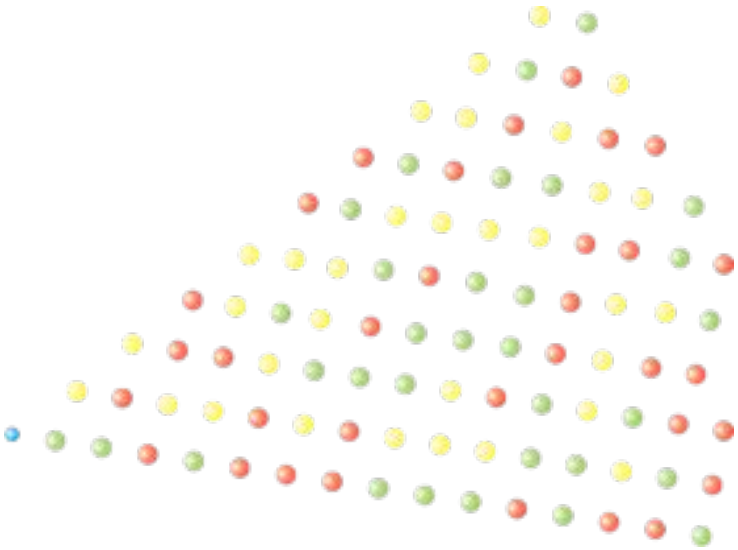
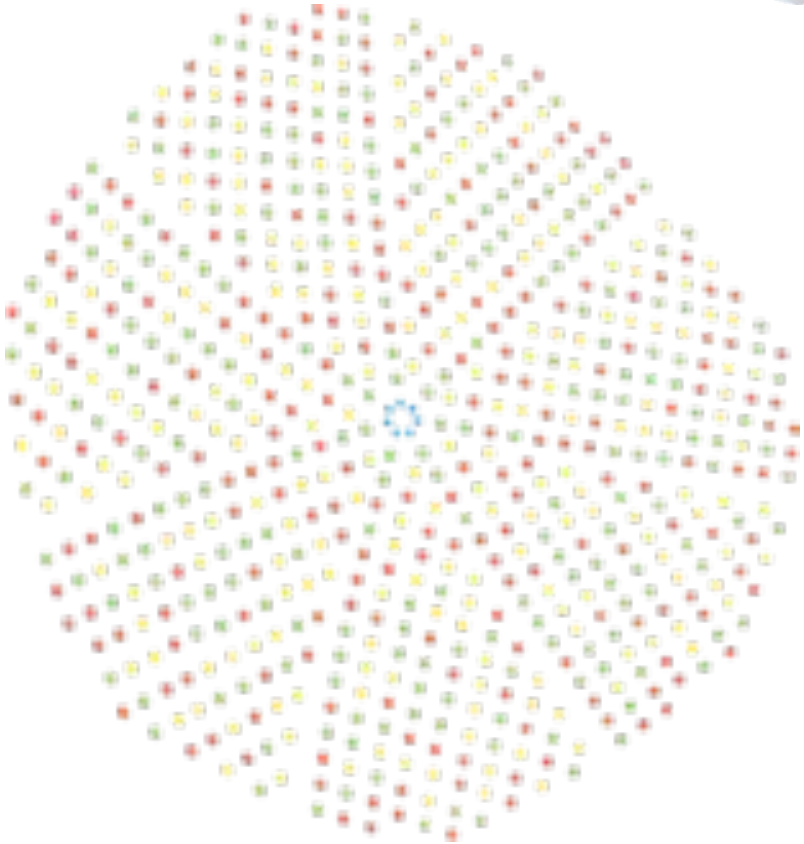
Color – coded Point-Source Analysis







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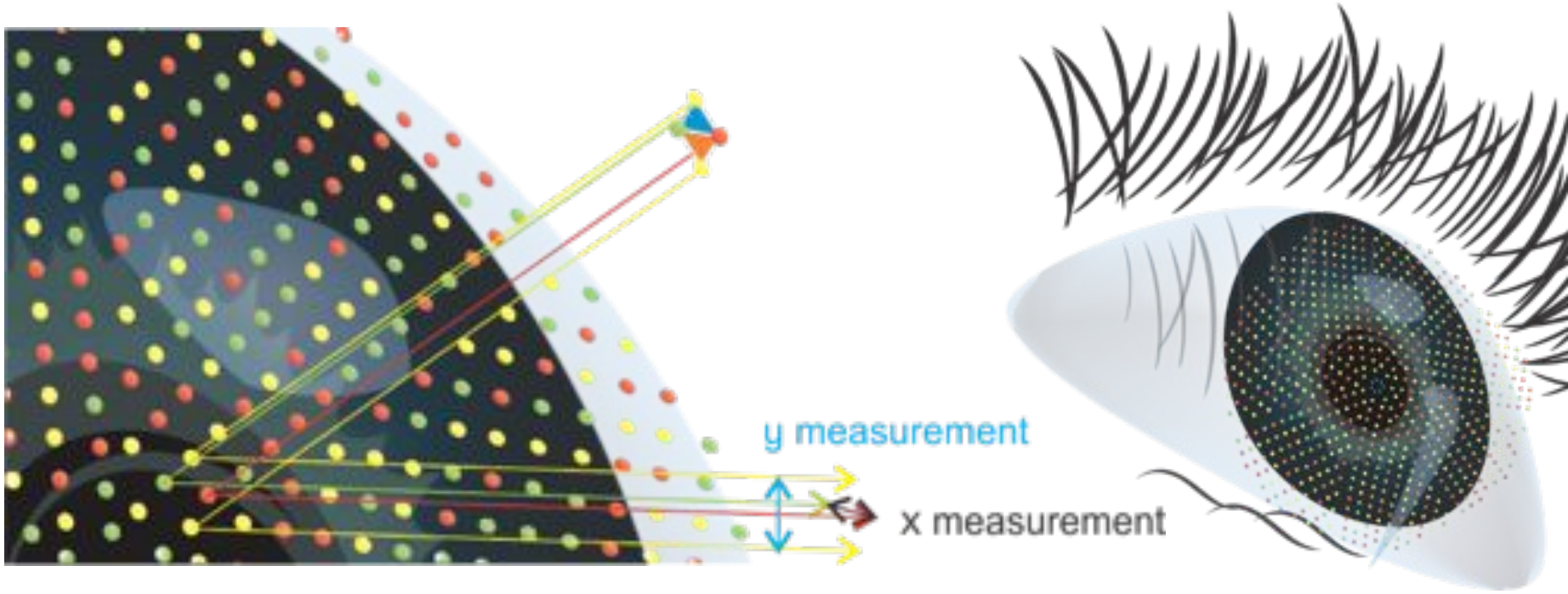
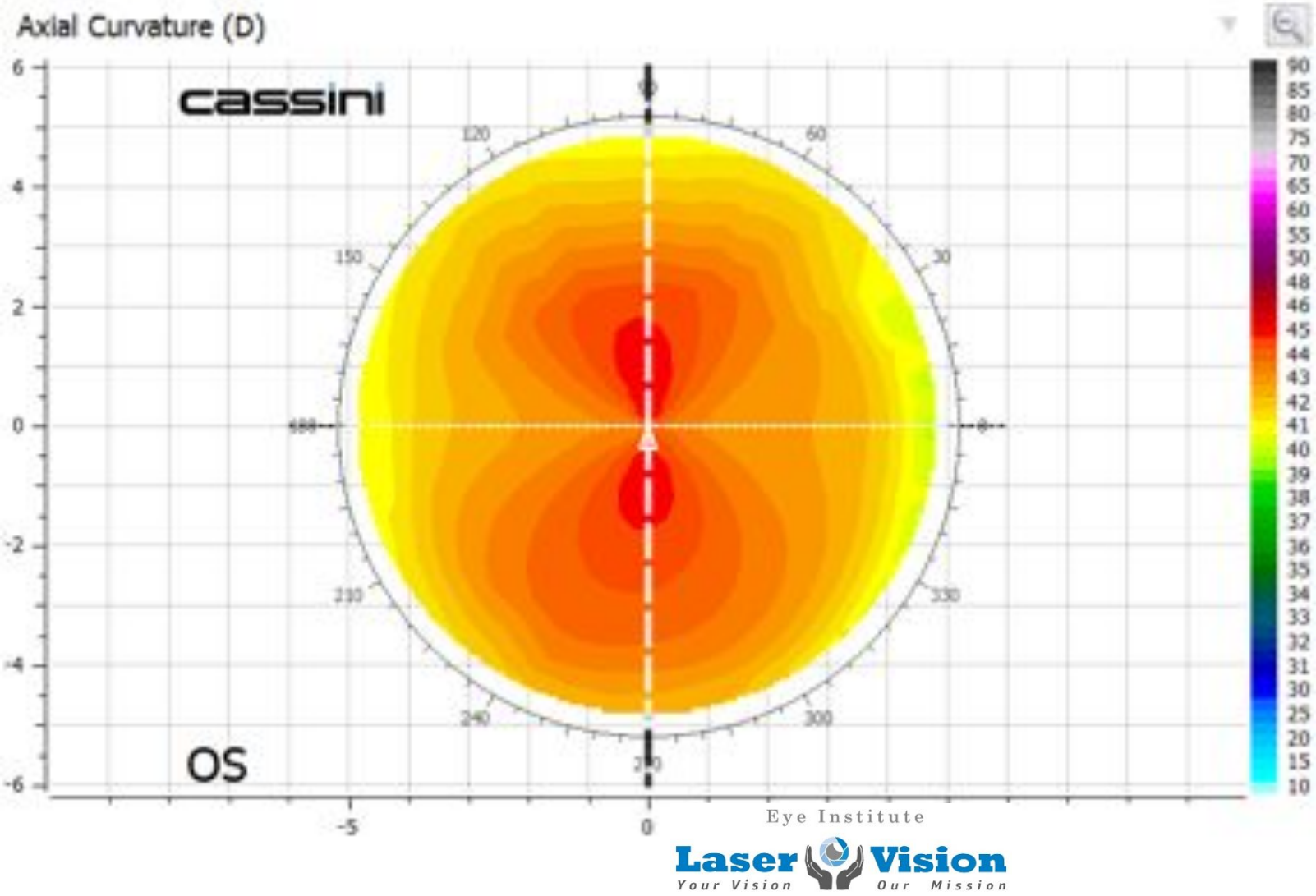
Color – coded Point-Source Analysis

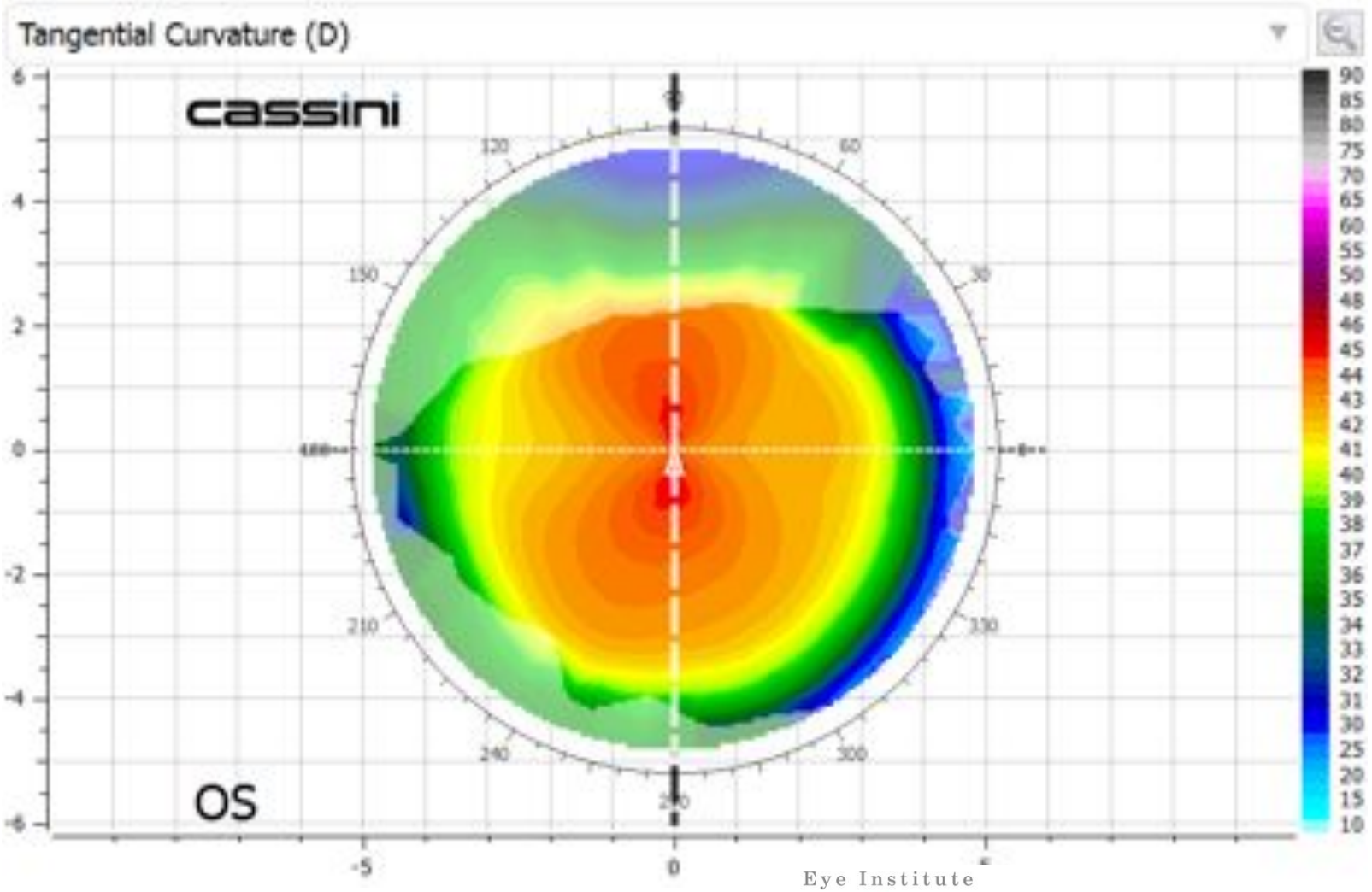


Point-pattern provides information in both coordinates

Axial Curvature Map



Tangential Curvature Map



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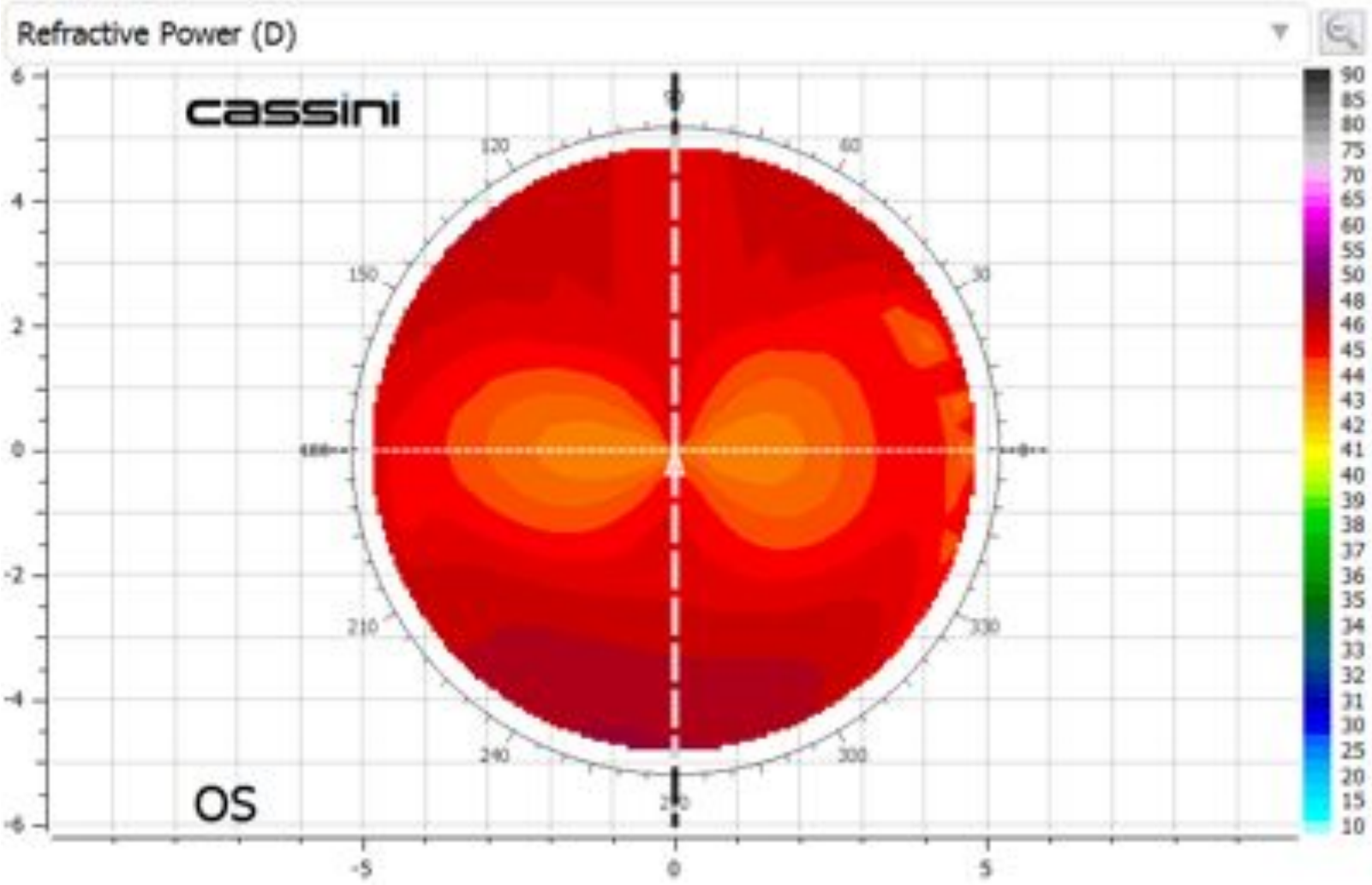
Refractive Power Map



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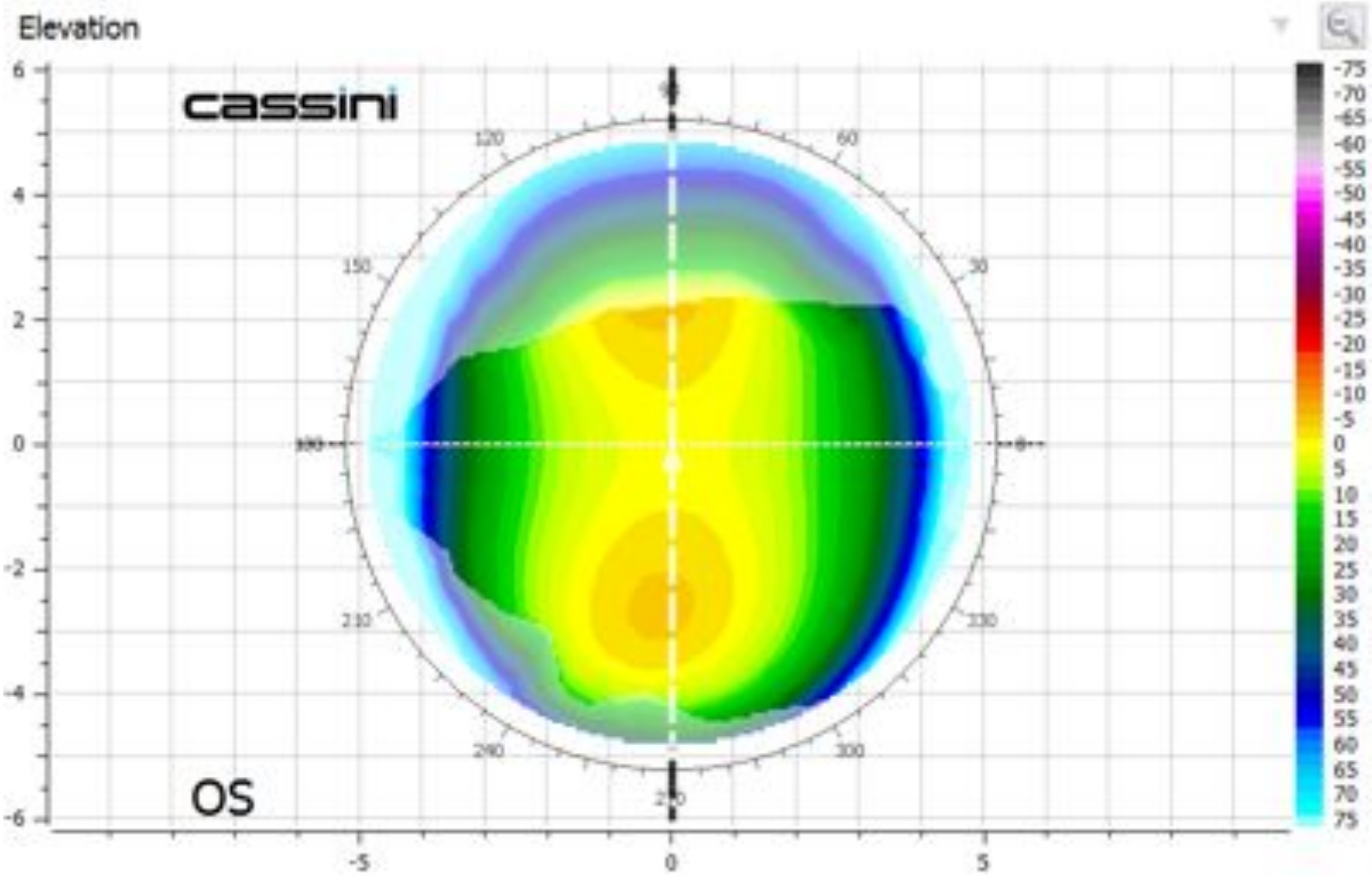
Anterior Elevation Map



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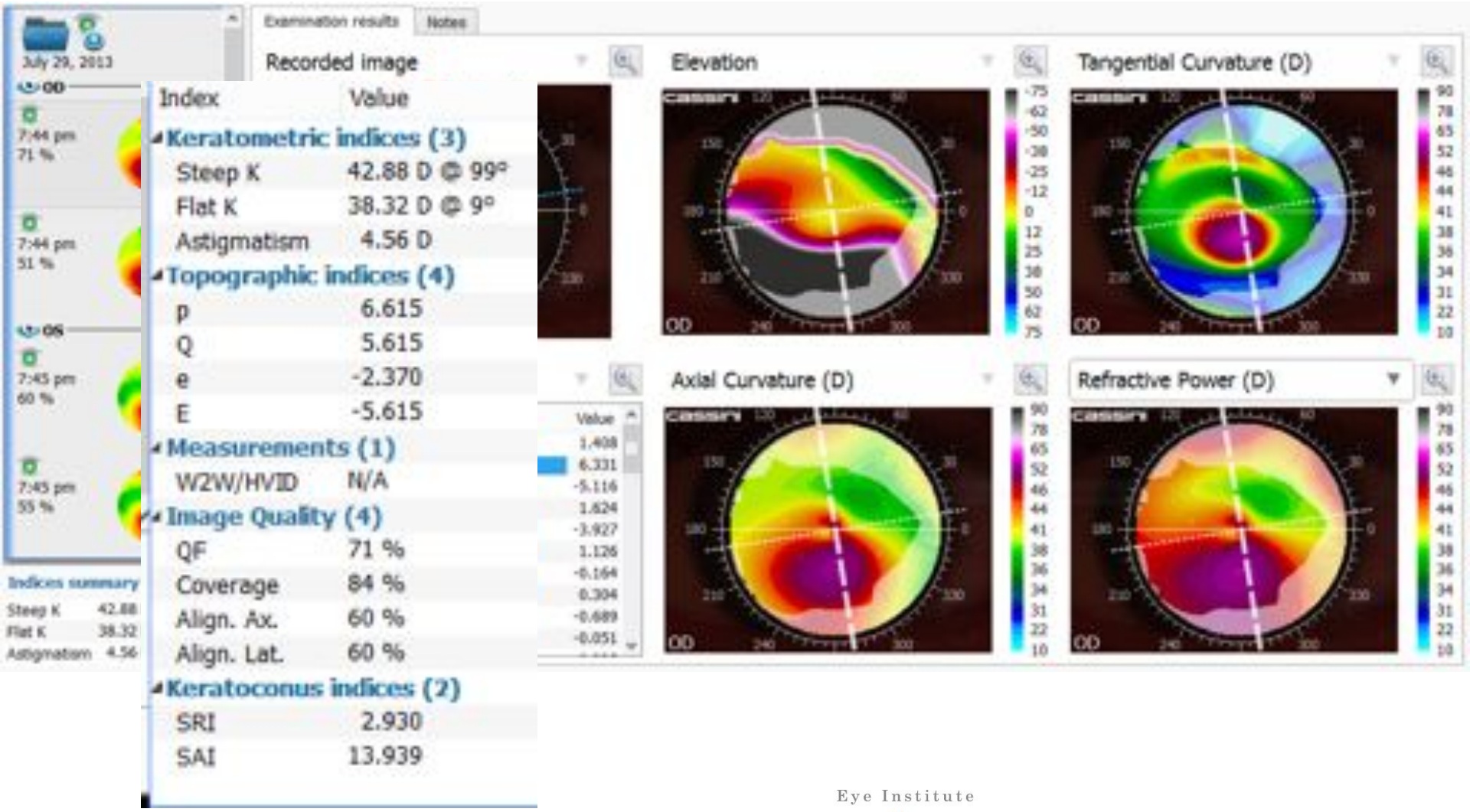
Keratoconus Imaging



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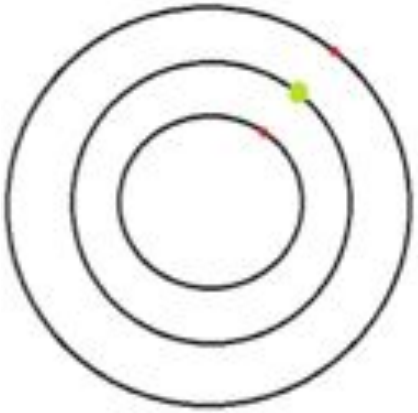
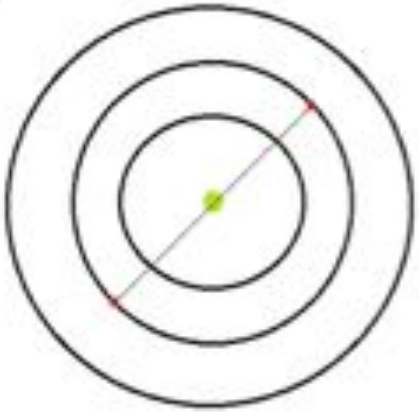
Keratoconus Indices

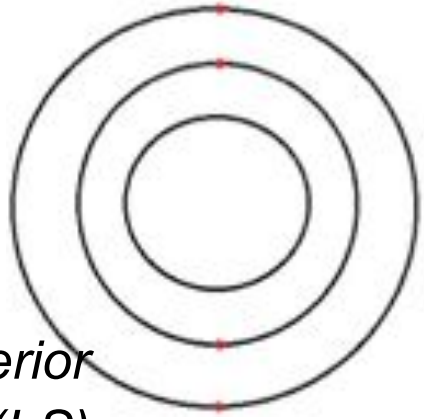
Index	Value
Keratometric indices (3)	
Steep K	42.88 D @ 99°
Flat K	38.32 D @ 9°
Astigmatism	4.56 D
Topographic indices (4)	
p	6.615
Q	5.615
e	-2.370
E	-5.615
Measurements (1)	
W2W/HVID	N/A
Image Quality (4)	
QF	71 %
Coverage	84 %
Align. Ax.	60 %
Align. Lat.	60 %
Keratoconus indices (2)	
SRI	2.930
SAI	13.939



Surface Regularity Index (SRI)



Surface Asymmetry Index (SAI)



Inferior-Superior Asymmetry (I-S)

+ 3rd, 4th order HOA @ 6mm zone

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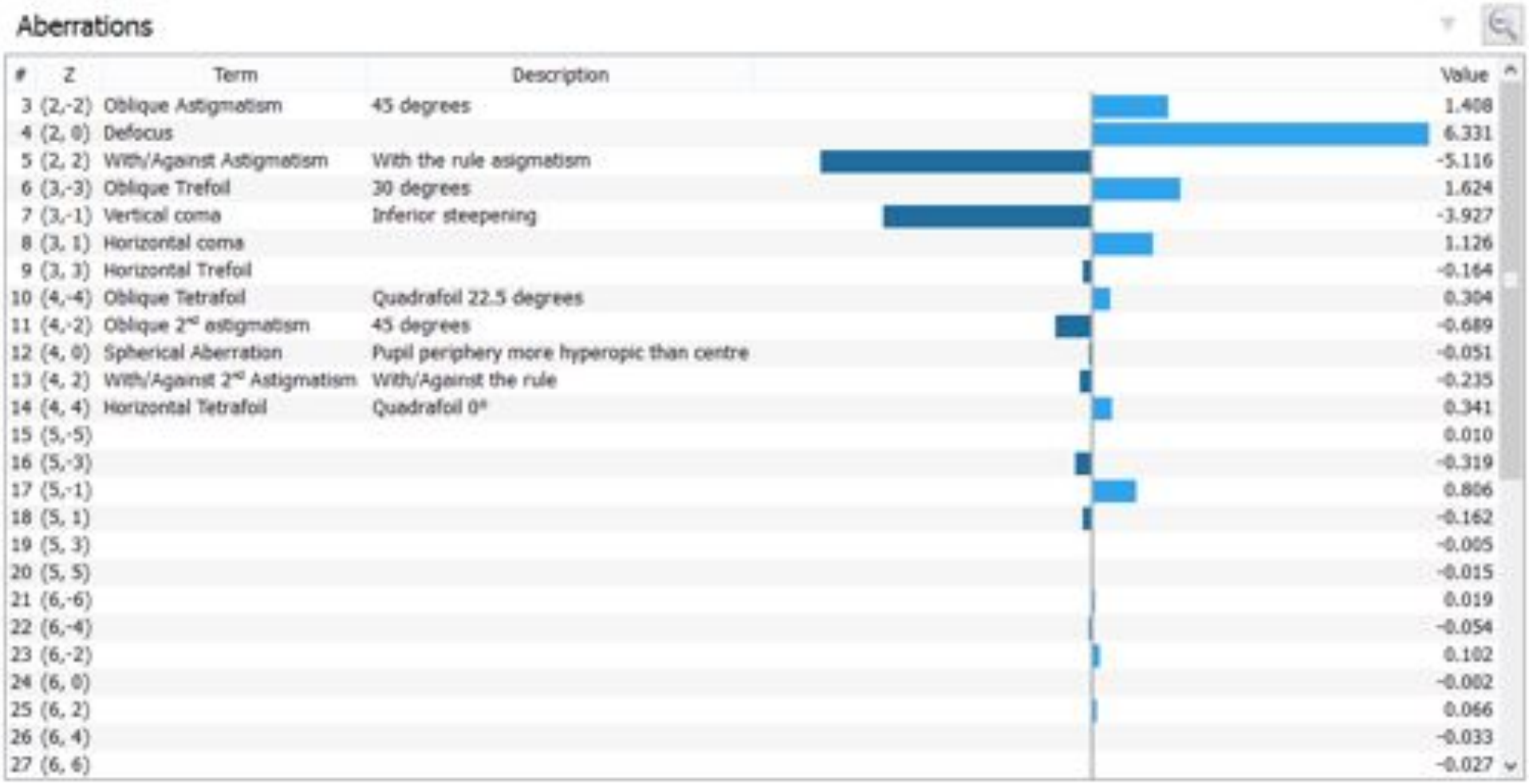
Keratoconus Imaging S



Aberrations

#	Z	Term	Description	Value
3	(2,-2)	Oblique Astigmatism	45 degrees	1.408
4	(2, 0)	Defocus		6.331
5	(2, 2)	With/Against Astigmatism	With the rule asigmatism	-5.116
6	(3,-3)	Oblique Trefoil	30 degrees	1.624
7	(3,-1)	Vertical coma	Inferior steepening	-3.927
8	(3, 1)	Horizontal coma		1.126
9	(3, 3)	Horizontal Trefoil		-0.164
10	(4,-4)	Oblique Tetrafoil	Quadrafoil 22.5 degrees	0.304
11	(4,-2)	Oblique 2nd astigmatism	45 degrees	-0.689
12	(4, 0)	Spherical Aberration	Pupil periphery more hyperopic than centre	-0.051
13	(4, 2)	With/Against 2nd Astigmatism	With/Against the rule	-0.235
14	(4, 4)	Horizontal Tetrafoil	Quadrafoil 0°	0.341
15	(5,-5)			0.010
16	(5,-3)			-0.319
17	(5,-1)			0.806
18	(5, 1)			-0.162
19	(5, 3)			-0.005
20	(5, 5)			-0.015
21	(6,-6)			0.019
22	(6,-4)			-0.054
23	(6,-2)			0.102
24	(6, 0)			-0.002
25	(6, 2)			0.066
26	(6, 4)			-0.033
27	(6, 6)			-0.027

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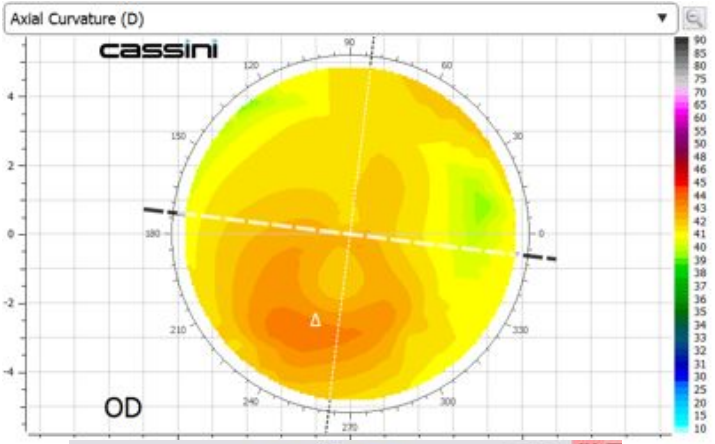
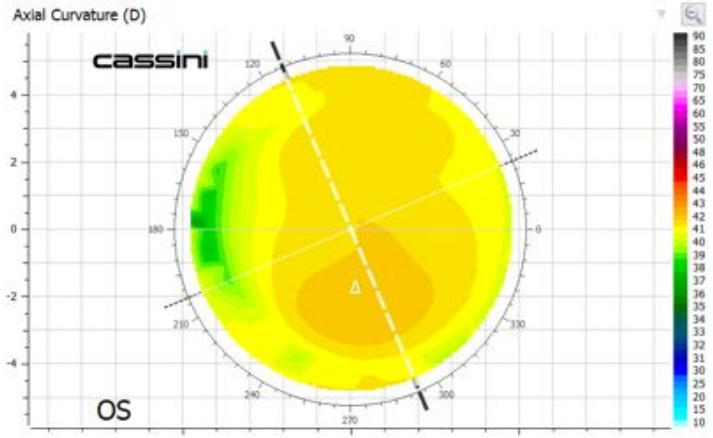
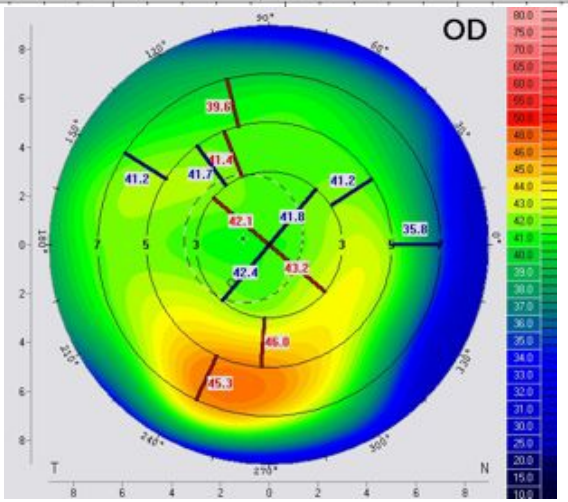
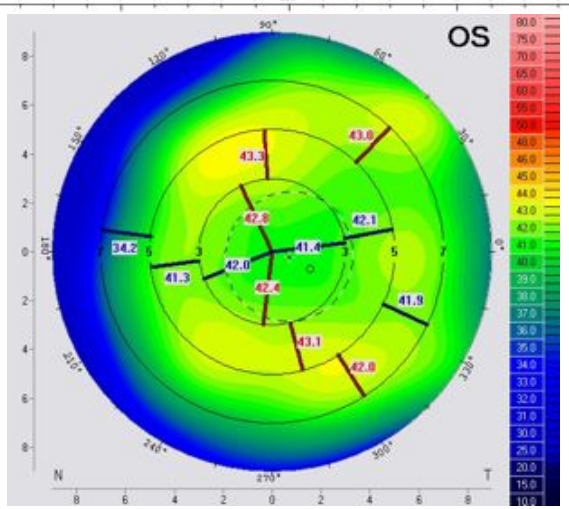
Forme Fruste Keratoconus

Cassini vs Scheimpflug









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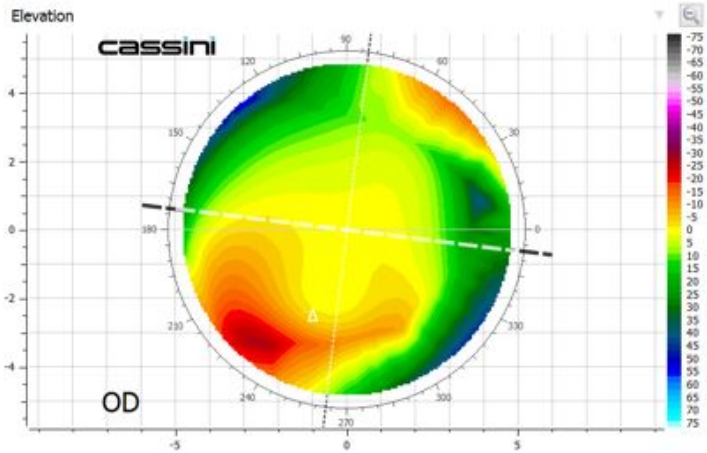
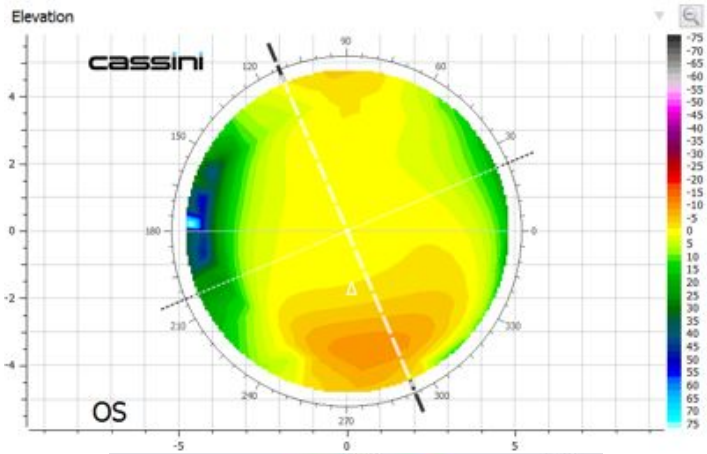
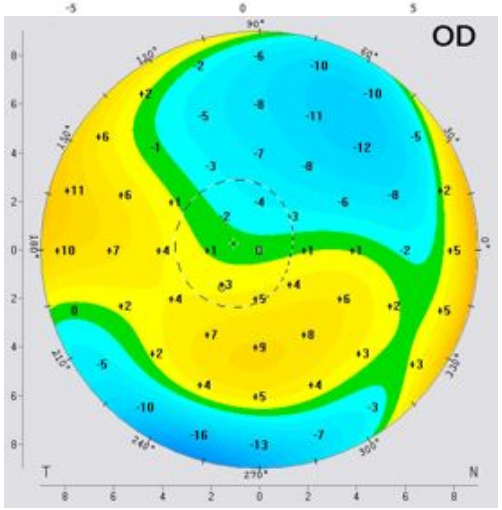
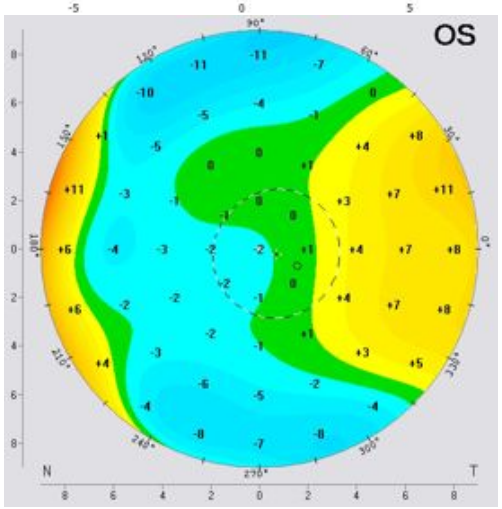
Forme Fruste Keratoconus

Cassini vs Scheimpflug









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Cassini vs Keratron

41 Normal eyes + 31 Keratoconus eyes + 31 Keratoconus Suspects

Irregular astigmatism (and cone shape)
Clinical signs with slit lamp evaluation

Fellow eye of keratoconus eye;
No irregular astigmatism;
No clinical signs

Cassini LED Corneal Topography

Keratron

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Cassini vs Keratron

	Normal Eyes			Keratoconus Suspects			Keratoconus		
	Cassini	**Keratron**	***p*-value**	**Cassini**	**Keratron**	***p*-value**	**Cassini**	**Keratron**	***p*-value**
SRI	1.04 ± 0.31	0.45 ± 0.39	$p<0.01$	1.55 ± 0.50	0.70 ± 0.73	$p<0.01$	2.39 ± 0.57	1.98 ± 0.65	$p<0.01$
3rd order HOA	0.44± 0.17	0.35 ± 0.13	$p=0.190$	1.03 ± 0.67	1.03 ± 0.64	$p=0.995$	3.42 ± 2.26	3.29 ± 1.37	$p=0.622$
4th order HOA	0.45 ± 0.11	0.35 ± 0.17	$p<0.01$	0.55 ± 0.19	0.52 ± 0.23	$p=0.422$	1.31 ± 0.62	1.17 ± 1.43	$p=0.406$

SRI measurements of the Cassini on normal eyes and keratoconus suspects suggest that the point-source reflection corneal topography is more sensitive in corneal irregularity.

Cassini has a possible advantage in distinguishing **keratoconus suspect eyes** from normal eyes **(using the SRI)**

Dr. Xin Zhang
xinzhang@alumni.cuhk.net

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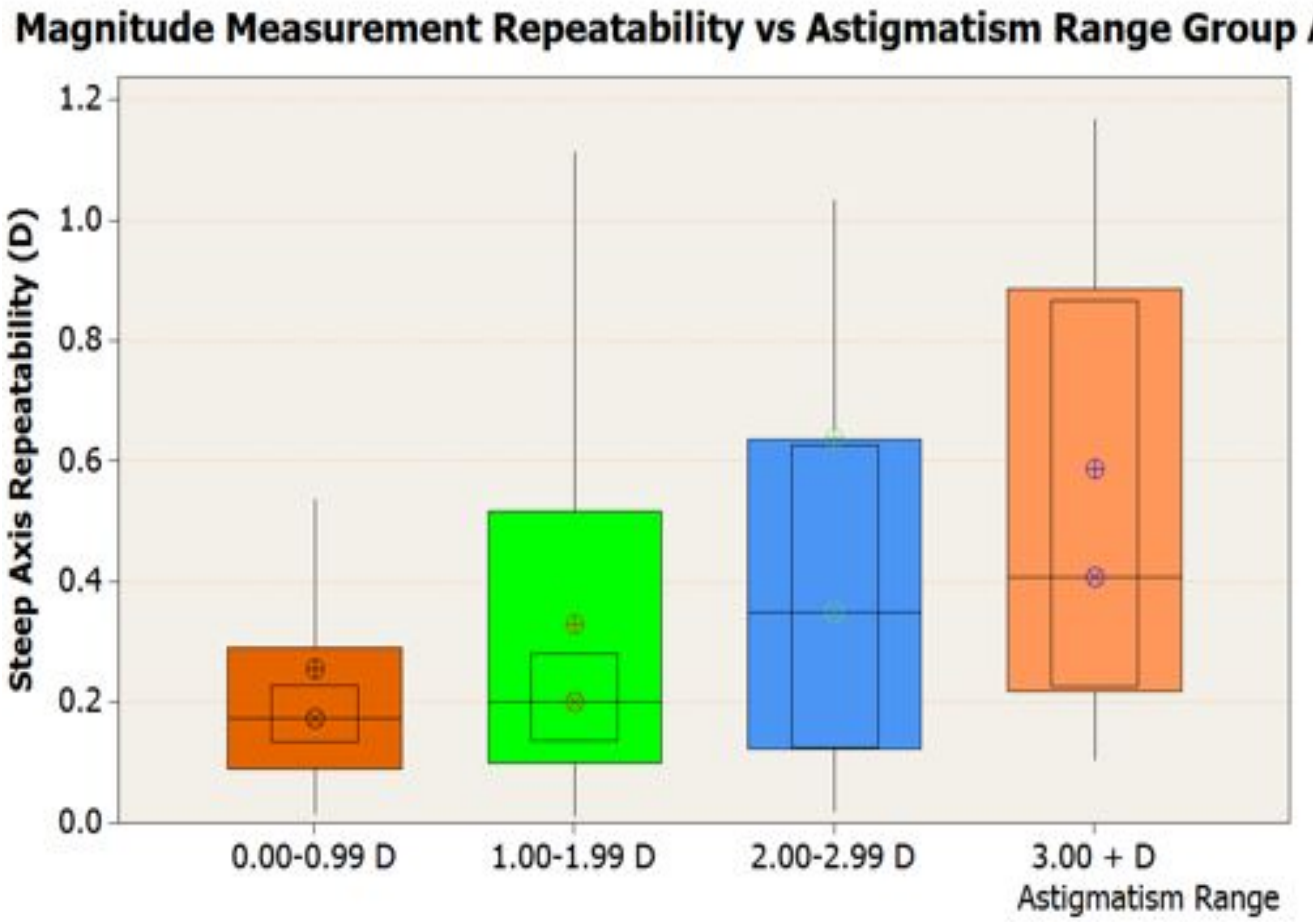
Materials & Methods

- Group A = 180 normal eyes
- Group B = 51 post-LASIK eyes
- Group C = 95 Keratoconus eyes
- Group D = 47 eyes with AP treatment (CXL+pPRK)

- 3 good quality measurements from each eye

Keratometric Repeatability (control, stratified Astigmatism)



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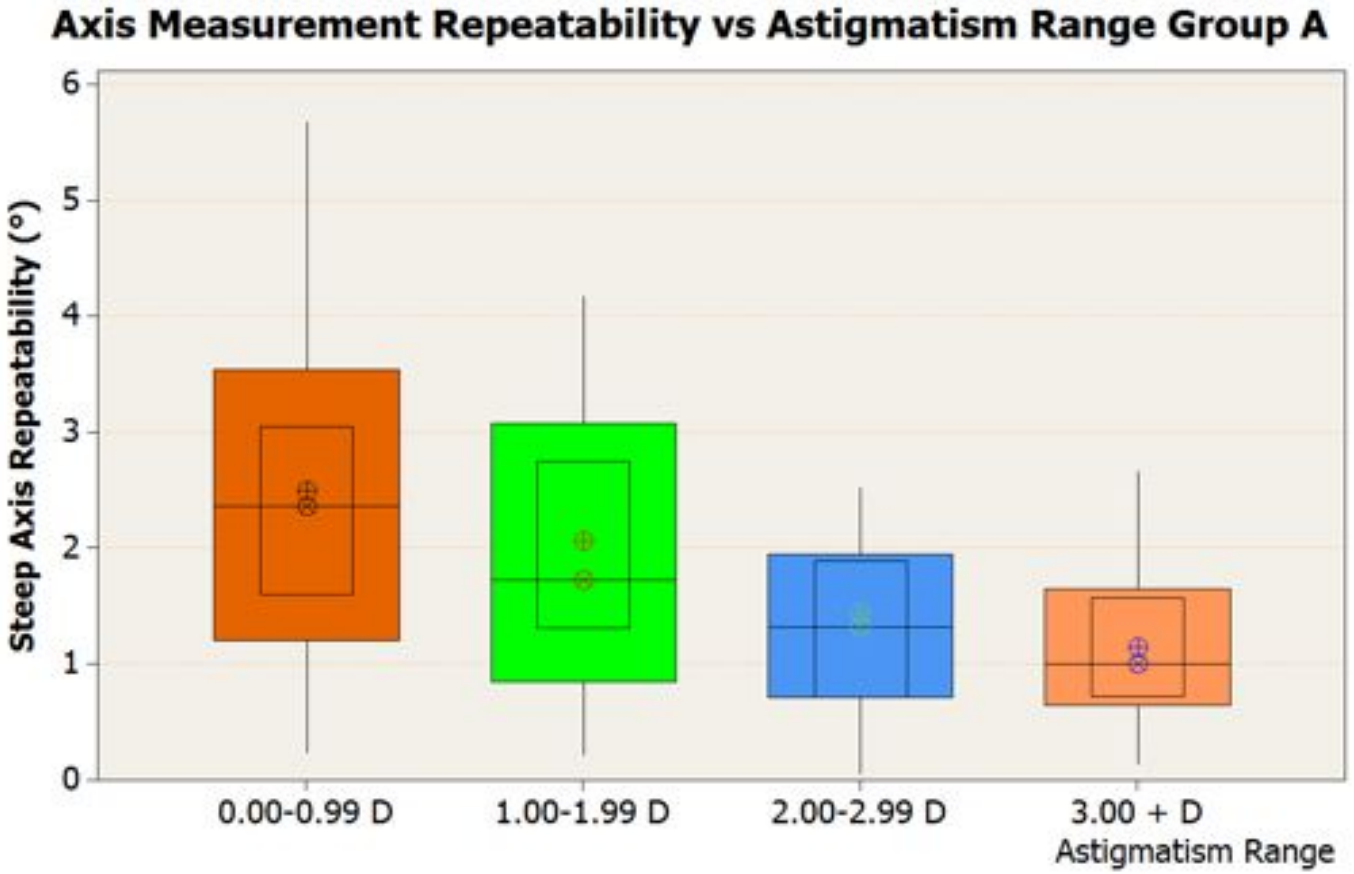
Keratometric Repeatability (axis) (control, stratified Astigmatism)



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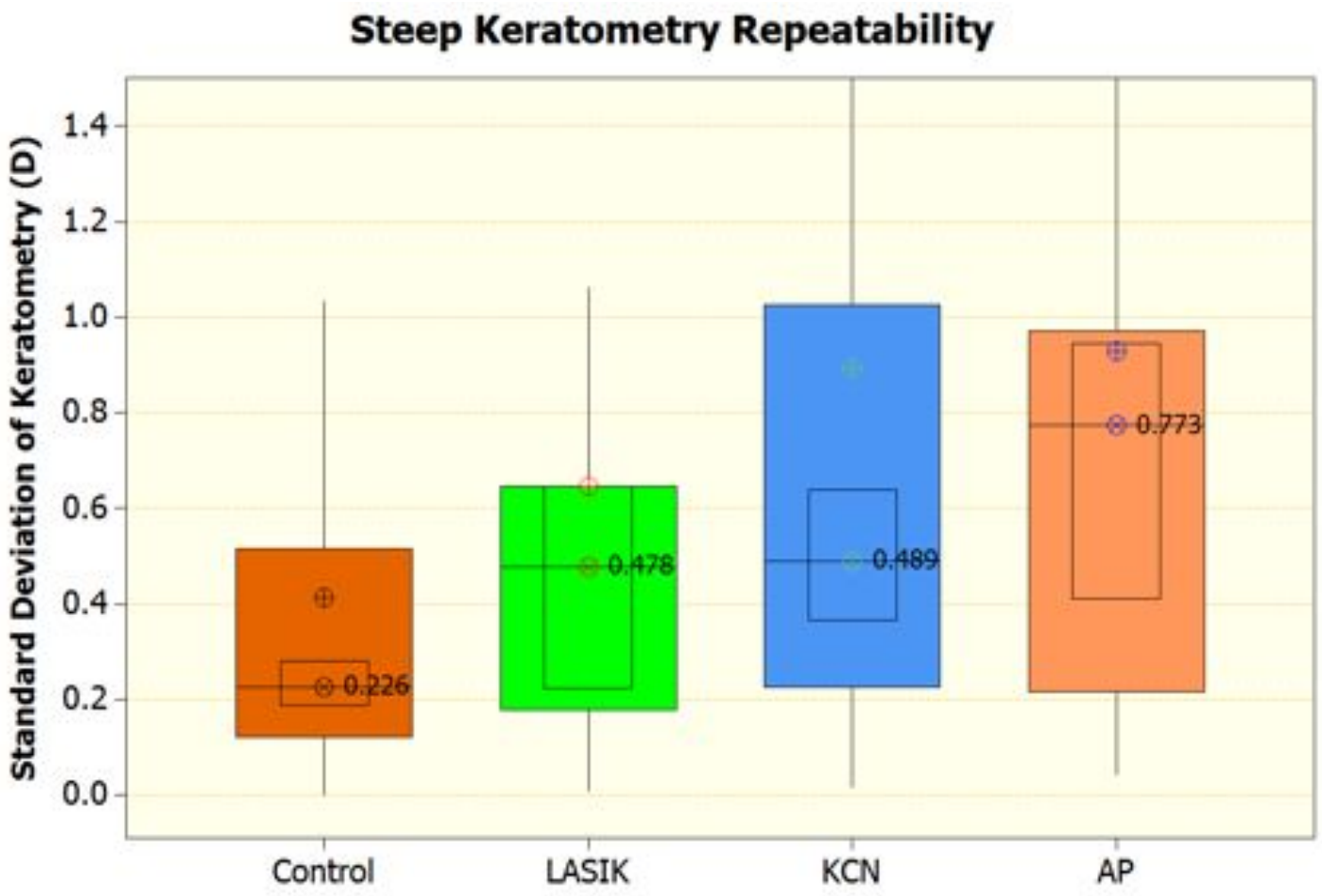
Keratometric Repeatability
Control, LASIK, KCN, Cross-linked (AP)



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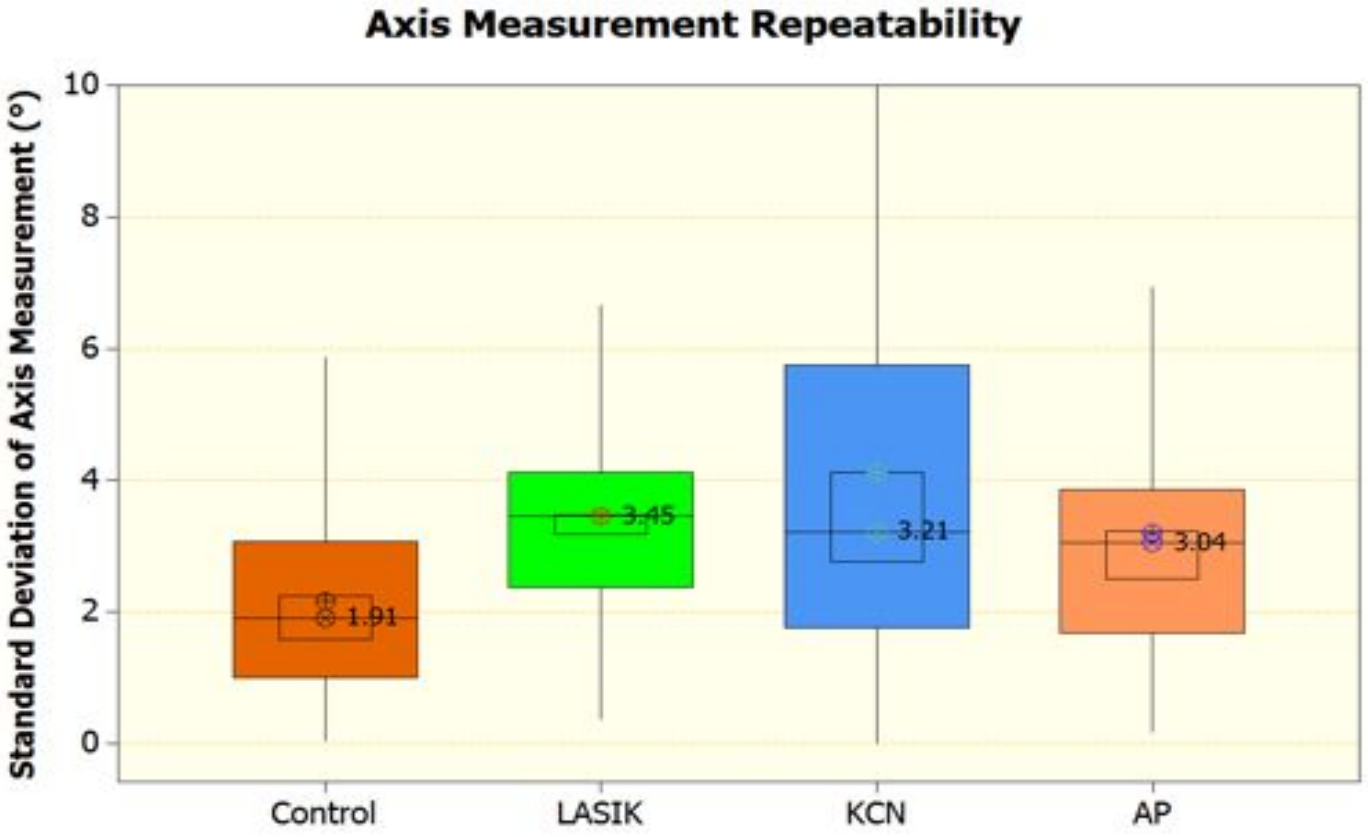
Keratometric Repeatability
Control, LASIK, KCN, Cross-linked (AP)



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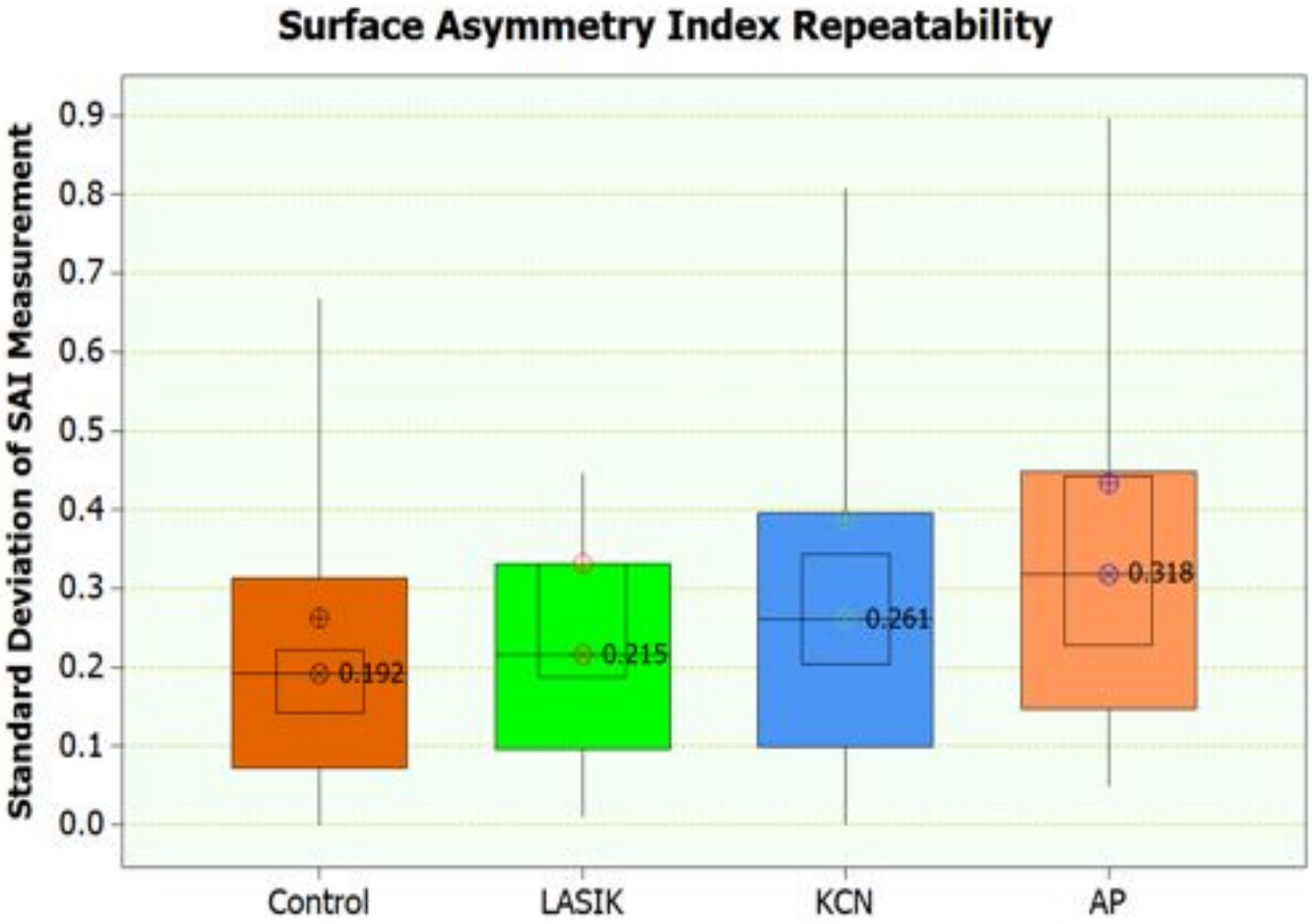
Keratoconic Indices Repeatability Control, LASIK, KCN, Cross-linked (AP)



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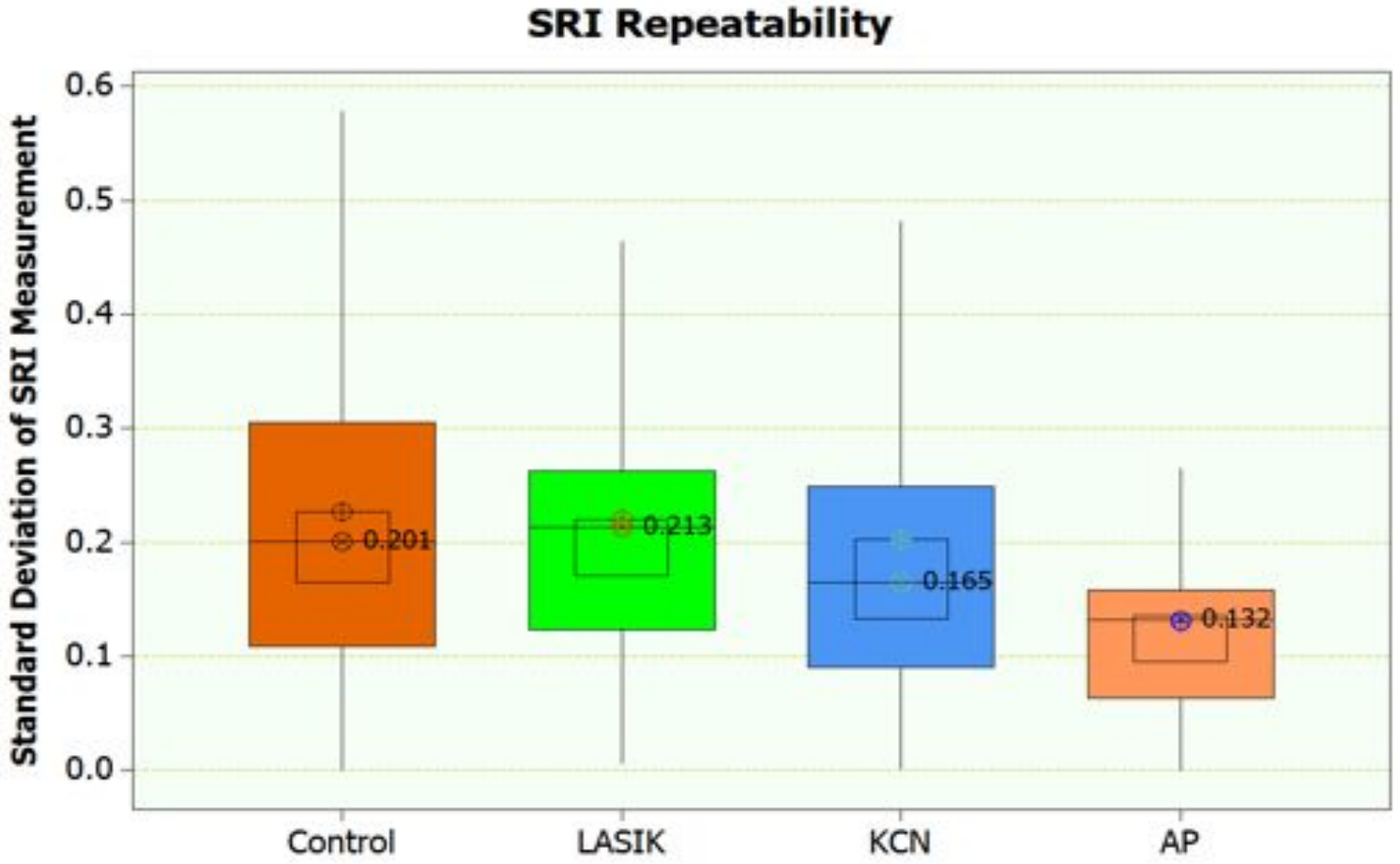
Keratoconic Indices Repeatability Control, LASIK, KCN, Cross-linked (AP)



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Conclusions

- Cassini Topography appears to offer
  - Very high specificity in estimating corneal keratometry and specific corneal irregularity indices even in topographically challenging corneas such as
    - LASIK-treated eyes
    - Keratoconic eyes
    - CXL eyes