

## POSTERIOR CORNEAL CHANGES IN SUPERIOR VS. TEMPORAL INCISIONS

The success of refractive lens surgery depends on accurate pre-operative keratometric readings and predictable post-phacoemulsification keratometric changes.

The majority of older cataract patients have against-the-rule (ATR) corneal astigmatism, with the steep meridian oriented along or close to 180°. With the advent and improvement of multifocal IOL technology offering one-in-all refractive solutions for presbyopia, myopia and astigmatism, refractive cataract or lens exchange patients are presenting progressively earlier. These younger patients often have with-the-rule (WTR), with the steep meridian oriented along or close to 90°.

Most refractive cataract surgeons are divided in opinion as to placement of phaco incisions, some adhering to a well entrenched dogma of operating on the steep meridian, which, in the case of younger patients, is often vertical, necessitating a superior incision.

The effect of incision placement on anterior K readings is well documented, with superior 3.5 mm incisions correcting as much as 1.5D of WTR astigmatism.<sup>1</sup> More recent data indicates superior 2.8 mm incisions correct as much as 0.75D of WTR astigmatism whilst temporal and nasal incisions remain relatively astigmatically neutral.<sup>2</sup>

Total corneal astigmatism is the sum of both the anterior and posterior astigmatism, and is of value as it influences post operative refraction.

In this article, we would also like to illustrate some of the possible changes the posterior cornea undergoes with different incision locations that should be taken into

account when planning refractive cataract surgery.

### Case 1

A 52-year-old lady with myopia and early cataracts presented for left refractive lens exchange. Keratometry was determined with the Galilei G4 combined Placido/Dual Scheimpflug Analyser (Ziemer AG, Port, Switzerland) which was then fed into the Lenstar LS900 optical biometer (Haag-Streit, U.S.A).

Keratometry revealed anterior WTR astigmatism of 0.54D and negligible ATR posterior corneal astigmatism. (Figure 1) During surgery, a 2.75 mm on-axis superior corneal incision was made, and a diffractive trifocal IOL implanted. On the first post-operative day, her uncorrected distance visual acuity (UCDVA) was 0.3 logMAR which did not improve at 1 week. Manifest refraction was plano/-1.50 x 090.

A repeat Galilei scan revealed flipping of the anterior keratometric axis, with significant increase of the anterior corneal astigmatism (0.54D pre-op to 1.17D post-op). Crucially, there was steepening of the posterior corneal surface with increase in ATR posterior corneal astigmatism (0.25D to 0.91D). The steepening was localized and involved the central 3 mm zone. (Figure 2)

### Case 2

A 49-year-old lady with myopia and early cataracts presented for right refractive lens exchange. IOL power was calculated combining keratometry from the Galilei G4 and axial length from the Lenstar.

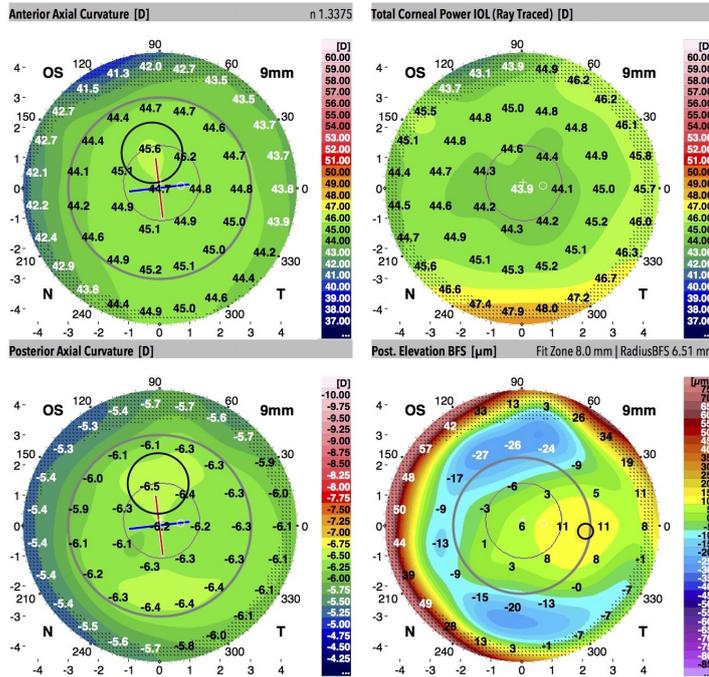
5042 Refractive Report

ziemer S

OS

SW V6.3.1

GALILEI G4



SimK		n 1.3375	
SimK	45.07D	R	7.49mm
Flat SimK	44.80D	7°	R1 7.53mm
Steep SimK	45.34D	97°	R2 7.44mm
Astig	0.54D	97°	e <sup>2</sup> (-Q) 0.12
Anterior Axial Curvature Zones			
Central	45.06D	7.49mm	
Mid	44.65D	7.56mm	
Periph	43.03D	7.84mm	
Kmax	45.65D	7.39mm	location x,y -0.25mm 0.87mm
Posterior Axial Curvature			
Mean K	-6.32D	R	6.33mm
Flat K	-6.19D	7°	R1 6.46mm
Steep K	-6.44D	97°	R2 6.21mm
Astig	-0.25D	97°	e <sup>2</sup> (-Q) 0.40
Pachymetry			
o Thinnest	487µm	x,y	0.69mm 0.09mm
Central	496µm	CCT	489µm
Mid	536µm		
Periph	599µm	Corneal Vol.	28.0mm <sup>3</sup>
Total Corneal Power IOL (Ray Traced)			
Mean TCPIOL	44.21D	Central	44.14D
Flat TCPIOL	44.03D	7°	Mid 44.97D
Steep TCPIOL	44.38D	97°	Periph 45.61D
Astig	0.34D	97°	
Anterior Chamber and Biometry			
WTW, N-T	11.81mm	Mean Angle	29.7°
ACV	89mm <sup>3</sup>	Kappa Dist	0.20mm
AQD	2.54mm	ASL endo	n/a
+ Pupil Diam	2.49mm	location x,y	0.04mm 0.20mm
Keratoconus Probability			
CLMlaa	0.35D	PPK	0.3%
Exam Label and Notes			

Figure 1: Mild WTR anterior and negligible ATR posterior astigmatism

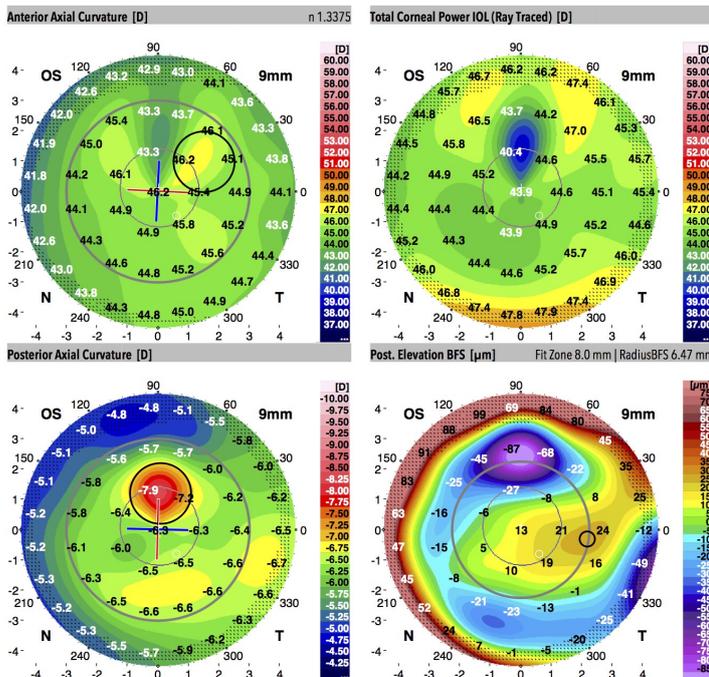
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GALILEI G4



SimK		n 1.3375	
SimK	44.56D	R	7.57mm
Flat SimK	43.67D	87°	R1 7.73mm
Steep SimK	45.45D	177°	R2 7.43mm
Astig	1.78D	177°	e <sup>2</sup> (-Q) 0.19
Anterior Axial Curvature Zones			
Central	45.20D	7.47mm	
Mid	44.75D	7.54mm	
Periph	43.17D	7.82mm	
Kmax	47.08D	7.17mm	location x,y 1.24mm 1.01mm
Posterior Axial Curvature			
Mean K	-6.75D	R	5.93mm
Flat K	-6.30D	179°	R1 6.35mm
Steep K	-7.20D	89°	R2 5.55mm
Astig	-0.91D	89°	e <sup>2</sup> (-Q) 0.54
Pachymetry			
o Thinnest	520µm	x,y	0.60mm -0.80mm
Central	537µm	CCT	526µm
Mid	589µm		
Periph	627µm	Corneal Vol.	30.5mm <sup>3</sup>
Total Corneal Power IOL (Ray Traced)			
Mean TCPIOL	43.14D	Central	43.96D
Flat TCPIOL	41.63D	88°	Mid 45.10D
Steep TCPIOL	44.65D	178°	Periph 45.87D
Astig	3.02D	178°	
Anterior Chamber and Biometry			
WTW, N-T	11.66mm	Mean Angle	37.6°
ACV	n/a	Kappa Dist	0.13mm
AQD	n/a	ASL endo	n/a
+ Pupil Diam	2.58mm	location x,y	0.02mm 0.13mm
Keratoconus Probability			
CLMlaa	1.38D	PPK	2.9%
Exam Label and Notes			

Figure 2: Moderate ATR anterior astigmatism, increased ATR posterior astigmatism with localized steepening encroaching central cornea

Keratometry revealed severe anterior WTR astigmatism of 2.61D and mild posterior ATR astigmatism of 0.56D. (Figure 3) A temporal 2.75 mm incision was made, and a toric progressive multifocal IOL was placed. Post operative day 1, her UCDVA was 0.0 logMAR, with uncorrected near visual acuity (UCNVA) J2 at 40cm. Manifest refraction was -0.25/-0.50 x 175.

Repeat Galilei scan revealed minimal anterior keratometric change (2.61D pre-op to 2.36D post-op, with no axis flipping), and crucially, negligible posterior keratometric change (0.56D pre-op to 0.58D post-op). (Figure 4)

**Case 3**

A 69-year-old lady with myopia and significant cataracts presented for right cataract surgery.

IOL power was calculated combining keratometry from the Galilei G4 and axial length from the Lenstar.

Keratometry revealed mild anterior WTR corneal astigmatism of 0.62D and mild posterior corneal ATR astigmatism of 0.47D. (Figure 5) A temporal 2.75 mm incision was made and an aspheric monofocal IOL was placed. Surgery was uncomplicated, and on the first-operative day, her UCDVA was 0.1 logMAR, with no subjective improvement at 1 week.

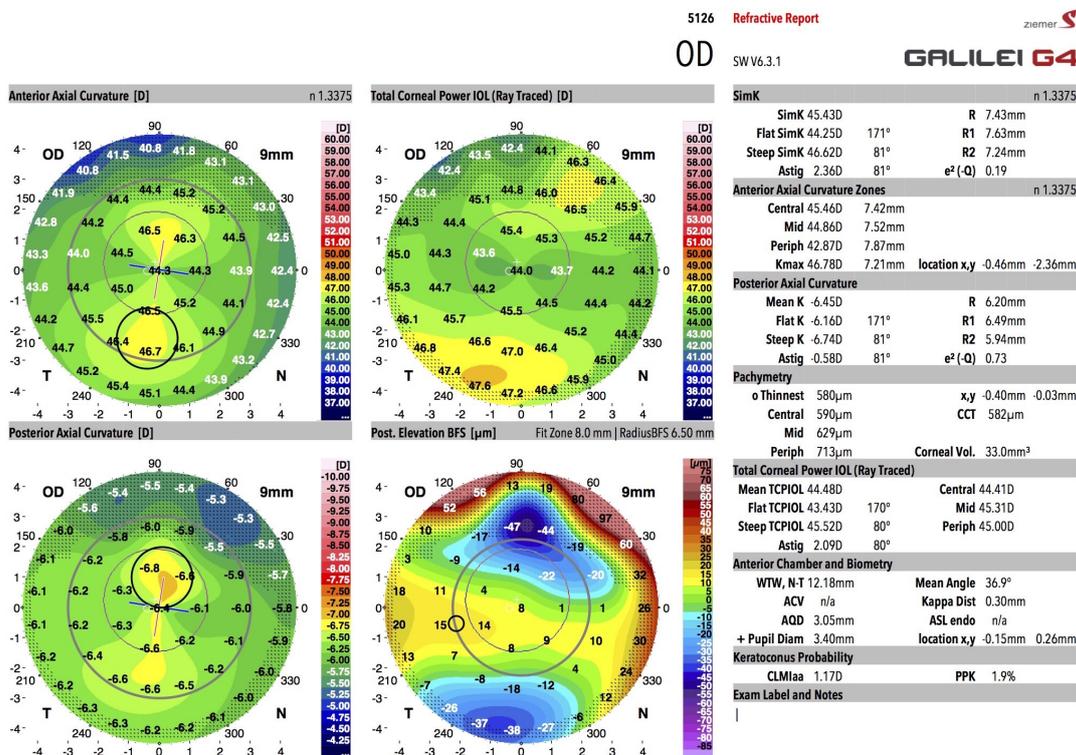


Figure 3: Severe WTR anterior and mild ATR posterior astigmatism

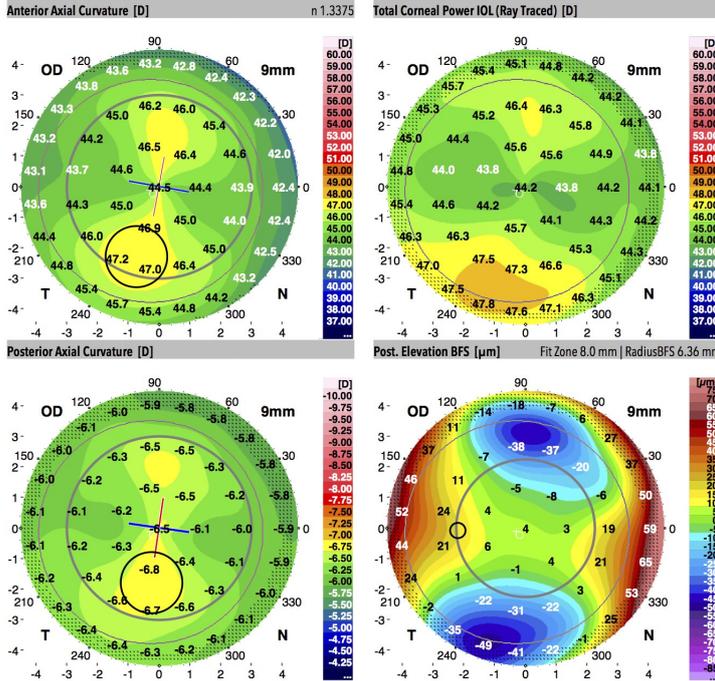
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GALILEI G4



SimK		n 1.3375	
SimK 45.61D	R 7.40mm		
Flat SimK 44.30D	170° R1 7.62mm		
Steep SimK 46.91D	80° R2 7.19mm		
Astig 2.61D	80° e <sup>2</sup> (-Q) 0.16		
Anterior Axial Curvature Zones		n 1.3375	
Central 45.53D	7.41mm		
Mid 45.19D	7.47mm		
Periph 43.20D	7.81mm		
Kmax 47.36D	7.13mm	location x,y	-0.86mm -2.13mm
Posterior Axial Curvature			
Mean K -6.42D	R 6.23mm		
Flat K -6.15D	172° R1 6.51mm		
Steep K -6.70D	82° R2 5.97mm		
Astig -0.56D	82° e <sup>2</sup> (-Q) 0.64		
Pachymetry			
o Thinnest 580μm	x,y -0.20mm -0.22mm		
Central 588μm	CCT 581μm		
Mid 623μm			
Periph 685μm	Corneal Vol. 32.6mm <sup>3</sup>		
Total Corneal Power IOL (Ray Traced)			
Mean TCPIOL 44.71D	Central 44.52D		
Flat TCPIOL 43.51D	170° Mid 45.50D		
Steep TCPIOL 45.91D	80° Periph 45.19D		
Astig 2.40D	80°		
Anterior Chamber and Biometry			
WTW, N-T 12.21mm	Mean Angle 43.7°		
ACV n/a	Kappa Dist 0.32mm		
AOD 3.14mm	ASL endo 6.32mm		
+ Pupil Diam 7.28mm	location x,y -0.30mm -0.11mm		
Keratoconus Probability			
CLMiaa 0.91D	PPK 1.1%		
Exam Label and Notes			

Figure 4: Negligible change in both anterior and posterior astigmatism

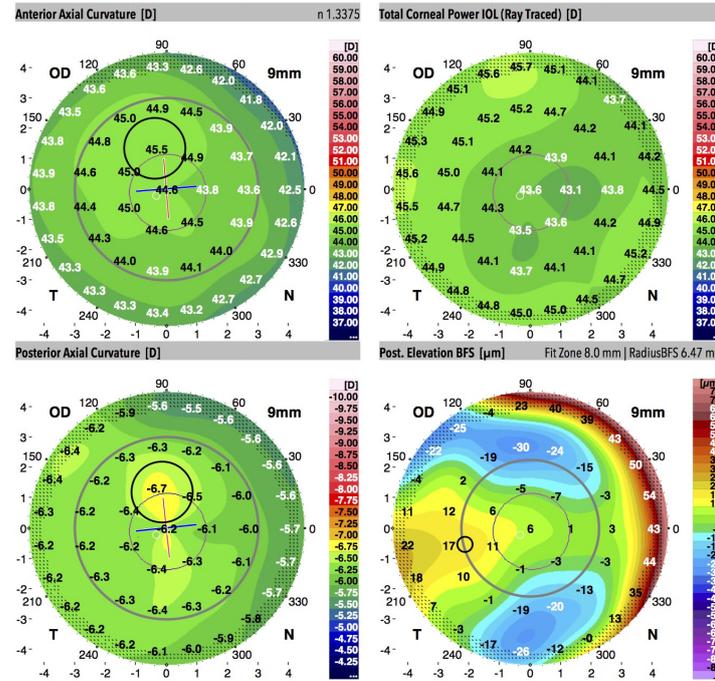
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SWV6.3.1

GALILEI G4



SimK		n 1.3375	
SimK 44.75D	R 7.54mm		
Flat SimK 44.45D	5° R1 7.59mm		
Steep SimK 45.06D	95° R2 7.49mm		
Astig 0.62D	95° e <sup>2</sup> (-Q) 0.30		
Anterior Axial Curvature Zones		n 1.3375	
Central 44.84D	7.53mm		
Mid 44.21D	7.63mm		
Periph 42.77D	7.89mm		
Kmax 45.48D	7.42mm	location x,y	-0.17mm 1.09mm
Posterior Axial Curvature			
Mean K -6.39D	R 6.26mm		
Flat K -6.15D	6° R1 6.50mm		
Steep K -6.63D	96° R2 6.03mm		
Astig -0.47D	96° e <sup>2</sup> (-Q) 0.58		
Pachymetry			
o Thinnest 572μm	x,y -0.34mm -0.22mm		
Central 581μm	CCT 572μm		
Mid 619μm			
Periph 673μm	Corneal Vol. 32.4mm <sup>3</sup>		
Total Corneal Power IOL (Ray Traced)			
Mean TCPIOL 43.74D	Central 43.76D		
Flat TCPIOL 43.64D	1° Mid 44.43D		
Steep TCPIOL 43.84D	91° Periph 44.74D		
Astig 0.20D	91°		
Anterior Chamber and Biometry			
WTW, N-T 11.84mm	Mean Angle 29.0°		
ACV 101mm <sup>3</sup>	Kappa Dist 0.09mm		
AOD 2.56mm	ASL endo n/a		
+ Pupil Diam 2.51mm	location x,y 0.02mm -0.09mm		
Keratoconus Probability			
CLMiaa 0.86D	PPK 1.0%		
Exam Label and Notes			

Figure 5: Mild WTR anterior and mild ATR posterior astigmatism

Galilei scan at 1 week was instructive. Though there was localized steepening of the posterior cornea at the incision site, it did not encroach the central 3 mm zone.

Keratometry remained relatively intact, with minimal anterior corneal changes (0.62 to 0.84D WTR) and mild posterior corneal changes (0.47D pre-op to 0.20D post-op). (Figure 6)

**Discussion**

The relatively neutral temporal incision is well documented. However, in the mentioned cases, we have demonstrated that unwanted steepening of the posterior cornea may occur regardless of incision location.

The above cases are instructive. Apart from suggested effects of gravity and the eyelid on superior incisions, the shorter vertical dimensions of the cornea, deep set eyes and prominent eyebrows often cause superior incisions to be placed anteriorly, with the inner wound edge encroaching into the central zone. This may necessitate steep angulation of the phaco probe, especially in myopic patients, with resulting localized distortion of the inner wound lip.

Temporal incisions tend to be more peripherally placed, in part due to ease of access and longer horizontal diameter. In addition, because the steepening effect is localized, peripheral incisions tend to have smaller effects on the central cornea.

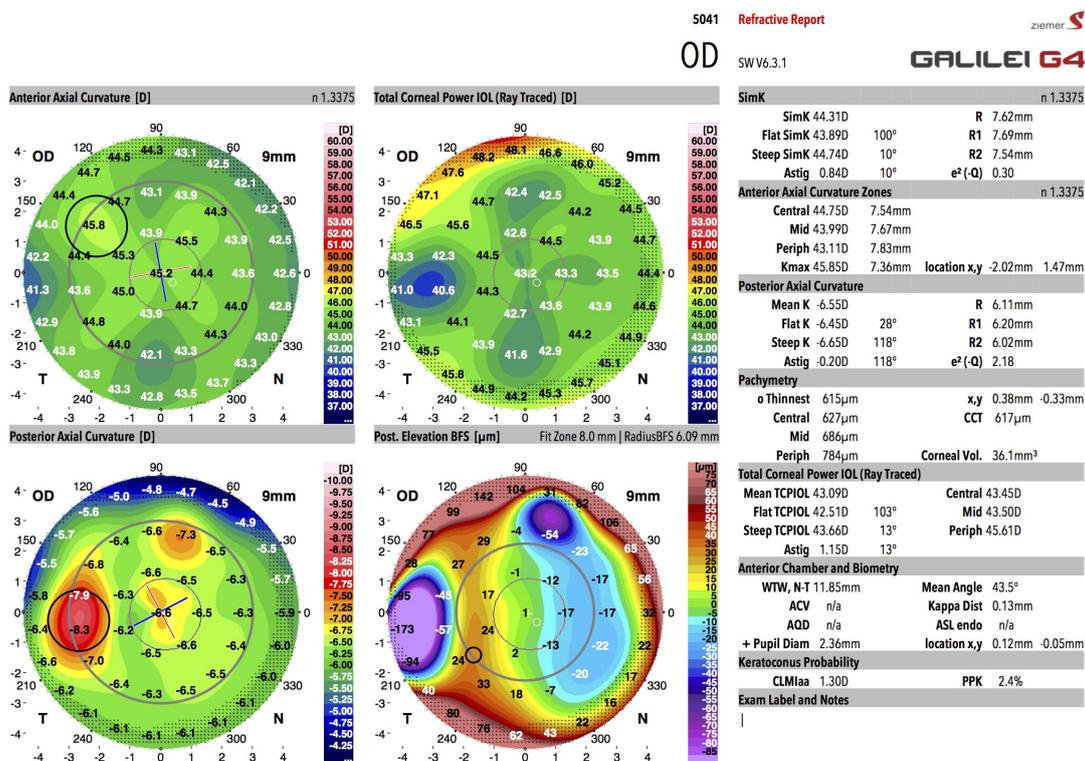


Figure 6: Negligible change in both anterior and posterior astigmatism with localized steepening peripheral, no encroachment of central cornea

## Conclusion

Refractive lens or cataract surgery depends on predictable keratometric changes. When planning the incision location, possible posterior corneal changes should be taken into consideration. Out of necessity, superior incisions may often be placed more anteriorly, increasing the risk of unwanted central posterior corneal changes influencing the central cornea.

## References

1. Jaime Tejedor, Juan Murube. *Choosing the Location of Corneal Incision Based on Preexisting Astigmatism in Phacoemulsification*. American Journal of Ophthalmology. May 2005. Volume 139, Issue 5, Pages 767–776
2. Jaime Tejedor; José A. Pérez-Rodríguez. *Astigmatic Change Induced by 2.8-mm Corneal Incisions for Cataract Surgery*. Investigative Ophthalmology & Visual Science March 2009, Vol.50, 989-994. doi:10.1167/iovs.08-2778



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