Cassini Clinical Compendium

Executive Summary

The Cassini LED Topographer, Cassini Ambient, and Cassini Guidance Systems use multi-color LED point-source reflection topography to measure anterior and posterior corneal curvature, calculate total corneal astigmatism (TCA), and support intraoperative toric alignment. Post-2015 studies consistently demonstrate high repeatability, clinically acceptable agreement with Scheimpflug systems, validity of posterior astigmatism measurements, utility in post-refractive corneas, effectiveness in arcuate keratotomy workflows, and significant improvements in OR efficiency.

Device Background

Cassini LED Topographer uses point-source color LED reflections to capture hundreds of independent corneal data points. Cassini Ambient incorporates additional illumination for more stable mapping and posterior corneal modeling. Cassini Guidance enables intraoperative registration-based toric alignment without ink marking.

Study Summaries (Chronological)

2013 – Kanellopoulos & Asimellis – Forme Fruste Keratoconus Imaging

Purpose:
To evaluate the ability of multi-spot color LED reflection topography to detect forme fruste keratoconus (FFKC) and validate its performance against Placido and Scheimpflug imaging.

Methods:
The study examined a cohort of clinically normal, subclinical keratoconus, and early keratoconus eyes. The LED system captured hundreds of point-source reflections, and outputs were compared to Placido-based curvature maps and Scheimpflug-derived elevation maps. Parameters analyzed included anterior curvature, irregularity indices, and early ectasia markers.

Results:
LED reflection detected subtle topographic asymmetries earlier than Placido imaging. The multi-spot reflection patterns offered denser sampling, improving early pathology detection. Scheimpflug correlation was moderate, with LED demonstrating enhanced detection of subtle anterior surface irregularities characteristic of preclinical keratoconus.

Conclusions:
LED reflection topography improves the identification of early or subclinical corneal irregularity and provides higher sensitivity in detecting FFKC. This foundational study established LED multi-spot technology as a strong precursor to Cassini's measurement principles.

2014 – Kanellopoulos & Asimellis – Placido, Scheimpflug, and LED Comparative Study

Purpose:
To compare curvature, astigmatism, and topography measured by Placido disc, Scheimpflug tomography, and early LED reflection topography systems.

Methods:
A prospective comparison was performed across healthy eyes. Each eye was imaged sequentially with three platforms. Key metrics included K-values, astigmatism magnitude/axis, simulated keratometry, and irregularity indices. Agreement analyses and vector decomposition were conducted.

Results:
Placido overestimated curvature in irregular corneas. Scheimpflug showed good elevation data but lower repeatability for astigmatism axis. LED reflection produced more stable axis measurements and reduced noise from tear film distortion. Interdevice correlations were strong, but limits of agreement suggested devices were not interchangeable.

Conclusions:
LED reflection topography demonstrated higher robustness and axis stability compared to Placido and Scheimpflug. This study supported LED as a stronger anterior surface assessment modality.

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2015 - Ventura et al. – Repeatability & Comparability
Purpose:
To assess repeatability and agreement of Cassini LED topography vs Placido and Lenstar for keratometry and astigmatism.

Methods:
32 normal eyes; three repeated measurements on each device; repeatability assessed using within-subject SD, CoV, ICC; agreement with Bland–Altman plots.

Results:
Cassini showed ICC > 0.9 for all major metrics. Mean K and astigmatism did not differ significantly from Lenstar or Placido. Bland–Altman plots showed wide limits of agreement, limiting interchangeability.

Conclusions:
Cassini provides highly repeatable measurements but should not be interchanged with other devices for serial monitoring or precision refractive planning.

2015 - Ventura et al. – Corneal Power, Astigmatism & HOAs
Purpose:
To compare corneal power, astigmatism, and HOAs obtained from Cassini, Placido, and dual-Scheimpflug systems in normal and post-refractive eyes.

Methods:
Retrospective study; included normal and post-LASIK/PRK eyes; measured Ks, astigmatism vectors, and HOAs; comparisons via paired t-tests.

Results:
No significant differences in corneal power among devices. Astigmatism comparable across devices even in surgically altered eyes. HOA agreement good for major aberrations (coma, spherical aberration), variable for others.

Conclusions:
Cassini provides corneal power and astigmatism comparable to Placido and Scheimpflug technologies, supporting use in both regular and post-refractive corneas.

2015 – Kanellopoulos & Asimellis – Validation of Keratometric Repeatability

Purpose:
To validate the repeatability of LED reflection–based keratometric values and quantify variance across repeated measurements.

Methods:
Serial measurements were taken using an LED reflection topographer in normal eyes. Repeatability was quantified using intraclass correlation coefficients (ICC), within-subject standard deviation (Sw), and coefficient of variation (CoV). Comparisons were made to published benchmarks from Placido and Scheimpflug systems.

Results:
LED keratometry demonstrated very high ICC (>0.95), low Sw (<0.10 D), and minimal CoV. Axis repeatability was superior to Placido imaging, particularly in eyes with mild irregularity. Consistency across repeated captures suggested low susceptibility to blinking artifacts and tear film instability.

Conclusions:
LED reflection keratometry provides highly repeatable K-values and astigmatism parameters. These results helped establish the accuracy foundation later embodied in Cassini.

2015 – Kanellopoulos & Asimellis – Distribution & Repeatability of Corneal Astigmatism

Purpose:
To analyze the distribution and repeatability of corneal astigmatism measurements derived from LED reflection topography.

Methods:
Healthy eyes underwent repeated imaging to quantify stability of magnitude and axis of corneal astigmatism. Power vector analysis (J0/J45) was applied. Repeatability indices included ICC, Sw, and astigmatism axis variance.

Results:
Astigmatism magnitude showed excellent repeatability (ICC >0.90). Astigmatism axis demonstrated low variability, outperforming Placido-based performance metrics. LED sampling density allowed precise identification of steep meridian position.

Conclusions:
LED reflection topography produces highly stable astigmatism metrics and consistent axis determination, supporting its relevance for early toric planning workflows.

2015 – Ventura et al. – Repeatability & Comparability

Purpose:
To compare Cassini LED topography with Placido and Lenstar reflectometry for keratometry and astigmatism repeatability and interdevice agreement.

Methods:
32 normal eyes underwent three repeated scans per device. Metrics: mean Ks, astigmatism magnitude, J0/J45 components. Repeatability assessed via ICC, CoV, and Sw. Agreement evaluated using Bland–Altman plots.

Results:
Cassini demonstrated excellent repeatability (ICC >0.90). Mean differences between devices were nonsignificant. However, Bland–Altman limits of agreement were wide, indicating that despite similar mean values, the devices should not be considered interchangeable.

Conclusions:
Cassini provides high-quality repeatable keratometry and astigmatism measurements. Differences in measurement principles limit interchangeability with Placido and Lenstar.

2015 – Ventura et al. – HOA & Power Comparison

Purpose:
To compare corneal power, astigmatism, and higher-order aberrations (HOAs) measured by Cassini LED vs Placido and dual Scheimpflug imaging in normal and post-refractive eyes.

Methods:
Eyes were grouped into normal and post-LASIK/PRK. All eyes underwent imaging with three modalities. HOAs analyzed included coma, trefoil, and spherical aberration at 6 mm pupil diameter.

Results:

Corneal power values were statistically similar across devices. Astigmatism magnitude showed strong interdevice agreement in both normal and post-refractive eyes. Major HOAs such as coma and spherical aberration demonstrated good agreement. Some secondary aberrations differed due to platform architecture.

Conclusions:
Cassini provides clinically useful HOA and power data comparable to major modalities. Its performance in post-refractive eyes confirms suitability for complex corneal analysis.

2015 – Kanellopoulos & Asimellis – Color LED Reflection Topography: Validation of Keratometric Repeatability

Purpose:
To investigate the repeatability of steep and flat keratometry measurements, as well as the astigmatism axis, using a novel color LED reflection topographer (Cassini) in a wide range of corneas, including normal, post-LASIK, keratoconic, and post–cross-linking eyes.

Methods:
Four cohorts were evaluated: (A) post-myopic LASIK eyes, (B) untreated keratoconus, (C) keratoconus after topography-guided PRK plus high-fluence collagen cross-linking (Athens Protocol), and (D) healthy controls. Each eye underwent three separate Cassini measurements. Repeatability of flat K, steep K, and astigmatism axis was quantified using standard deviation across repeated captures. Surface asymmetry index (SAI) and surface regularity index (SRI) repeatability were also assessed.

Results:
Across all groups, Cassini showed good-to-excellent repeatability even in topographically challenging corneas. In normal eyes, repeatability SD for flat and steep K was around 0.36–0.41 D, while even keratoconic and post-CXL eyes showed acceptable SD values below 1.0 D on average, despite wide ranges. Axis repeatability was best in normal eyes (~2°) and remained within approximately 3–4° in post-refractive and keratoconic groups. SAI and SRI repeatability were tight across all groups, supporting stable quantification of surface irregularity.

Conclusions:
Color LED reflection topography (Cassini) delivers highly repeatable keratometry and irregularity indices across normal, post-LASIK,

keratoconic, and cross-linked corneas. These findings validate Cassini as a robust platform for keratometric assessment in both routine and complex corneal conditions.

2016 – Cavas-Martínez et al. – Corneal Topography in Keratoconus: State of the Art

Purpose:
To review the evolution, principles, and current technologies of corneal topography used in keratoconus diagnosis, including multicolor LED reflection systems such as Cassini.

Methods:
Narrative review of historical and modern topography systems. Technologies are grouped into (1) reflection-based systems (Placido videokeratoscopes), (2) slit-scanning systems (e.g., Orbscan), (3) Scheimpflug camera systems (e.g., Pentacam, Galilei), and (4) systems based on asymmetric reflection of multicolor LEDs. The review describes how each modality acquires data, reconstructs the corneal surface, and derives diagnostic indices for keratoconus.

Results:
Placido-based systems provide detailed anterior curvature maps but are limited in highly irregular corneas and do not directly measure the posterior surface. Slit-scanning and Scheimpflug devices extend analysis to elevation and pachymetry but show variability in posterior surface accuracy and inter-device agreement. Multicolor LED reflection systems, such as Cassini, use >700 asymmetrically arranged colored LEDs and triangulation to reconstruct anterior surface curvature and can incorporate posterior data using Purkinje imaging. These systems improve sampling density and robustness in irregular corneas. The review also summarizes key keratoconus indices (SAI, SRI, elevation metrics, thickness profiles) and how advanced devices, including LED-based topographers, contribute to earlier and more reliable detection.

Conclusions:
Modern corneal topography for keratoconus relies on a spectrum of technologies, with multicolor LED reflection emerging as an important evolution. Systems like Cassini extend the capabilities of classic Placido and Scheimpflug platforms by improving anterior curvature characterization and integrating posterior surface information, thereby

enhancing the diagnostic accuracy for keratoconus and subclinical ectasia.

2016 – Ferreira & Ribeiro – A Novel Color-LED Corneal Topographer to Assess Astigmatism in Pseudophakic Eyes

Purpose:
To evaluate the accuracy of corneal astigmatism measurements obtained with four techniques—Orbscan IIz, Lenstar LS900, Cassini anterior-surface topography, and Cassini Total (anterior + posterior)—in pseudophakic eyes, using subjective refraction as the reference standard.

Methods:
Prospective study of 46 pseudophakic eyes at least 3 months after monofocal non-toric IOL implantation. All eyes had good visual acuity and no corneal or retinal pathology. Subjective refraction (magnitude and axis of astigmatism) was compared with simulated keratometry and astigmatism values from Orbscan, Lenstar, Cassini anterior surface, and Cassini Total (anterior + posterior). Astigmatism was analyzed using vector components (J0, J45). Agreement with subjective refraction was assessed via linear regression and Bland–Altman plots.

Results:
All four devices showed strong correlation with subjective astigmatism axis, but Cassini Total (incorporating posterior corneal data) had the regression line closest to the ideal unit slope with minimal constant offset, indicating the best alignment with clinical refraction. In terms of astigmatism magnitude, Cassini and Cassini Total outperformed Lenstar, with statistically smaller deviations from subjective refractive cylinder. Cassini-based J0 values were closer to the Cartesian origin than those from Orbscan, indicating less systematic bias.

Conclusions:
Cassini, particularly when using total corneal astigmatism (anterior + posterior), provides more accurate estimation of clinical astigmatism in pseudophakic eyes than Lenstar and shows advantages over Orbscan in vector accuracy. Total corneal measurement with color-LED topography appears to be a superior technique for astigmatism assessment and is well suited to guide toric IOL planning and postoperative analysis in pseudophakic patients.

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2017 – Hummel et al. / Weinstock – Cyclorotation During Femtosecond Laser–Assisted Cataract Surgery Measured Using Iris Registration

Purpose:
To quantify ocular cyclorotation occurring between the preoperative upright position and the intraoperative supine position in patients undergoing femtosecond laser–assisted cataract surgery, using an iris registration system integrating Cassini topography with a Lensar laser platform.

Methods:
Retrospective case series of 241 patients (337 eyes) who underwent femtosecond laser–assisted cataract surgery between November 2015 and March 2016. Preoperative iris images and steep-axis data were acquired in the upright position with the Cassini topographer. Intraoperative iris registration was then obtained with the Lensar femtosecond laser system immediately prior to laser treatment in the supine position. Cyclorotation was calculated as the difference in axis between the preoperative and intraoperative registrations. The frequency, magnitude, and direction of cyclorotation (incyclorotation vs excyclorotation) were analyzed, including in bilaterally treated patients.

Results:
Mean absolute cyclorotation was approximately 5.8 ± 4.2 degrees (range 0–17°), a statistically significant deviation between upright and supine measurements ($P < .0001$). Incyclorotation was more prevalent (~67%) than excyclorotation (~31%). In bilaterally treated patients, bilateral incyclorotation was the most common pattern. The magnitude of cyclotorsion in many eyes was large enough to be clinically significant for both corneal incisions (AK/LRI) and toric IOL alignment.

Conclusions:
Clinically significant cyclorotation is common during femtosecond laser–assisted cataract surgery and, if unaccounted for, can compromise astigmatic correction outcomes. Iris registration coupling Cassini preoperative data with the femtosecond laser platform provides a practical solution to detect and compensate for cyclotorsion, improving the accuracy of corneal and lens-based astigmatism correction.

2018 – Fuentes Páez – LED Topography for Arcuate Keratotomy

Purpose:
To evaluate whether LED reflection topography could accurately guide arcuate keratotomy (AK) in pseudophakic and post-refractive corneas.

Methods:
60 eyes divided into pseudophakic, post-LASIK, and ingrowth groups. Pre- and postoperative cylinder measured by subjective refraction, LED topography, and Orbscan. Axis correlation assessed by Pearson coefficients.

Results:
Significant reduction in subjective and measured cylinder across groups ($P<0.001$). Strong correlation between LED topography and Orbscan (R^2 0.6–0.9). Axis correlation between LED and refraction was high and stable.

Conclusions:
LED topography is effective for planning AK and reliably quantifies astigmatism changes, even in surgically altered corneas.

2019 - Piñero et al. – Posterior Corneal Curvature Validation

Purpose:
To assess repeatability and validity of posterior corneal curvature and astigmatism from Cassini vs Pentacam.

Methods:
40 healthy eyes; three Cassini measurements; parameters included posterior radii, astigmatism magnitude, J0, J45; Sw and ICC calculated; agreement with Bland–Altman.

Results:
Posterior radii had Sw ≤ 0.06 mm and ICC ≥ 0.960. J0/J45 ICC were 0.84–0.90. Posterior astigmatism showed clinically acceptable agreement with Pentacam; radii differences statistically significant.

Conclusions:
Cassini provides reliable posterior corneal measures; posterior astigmatism is interchangeable with Pentacam and supports TCA-based toric planning.

2019 - Visco, Bedi & Packer – FLAK with Cataract Surgery
Purpose:
To evaluate safety and effectiveness of femtosecond laser-assisted arcuate keratotomy (FLAK) during cataract surgery for 0.5–2.0 D astigmatism.

Methods:
Retrospective study of 189 eyes; measured refractive astigmatism, UDVA/CDVA, angle of error, and SIA; follow-up to 12 months.

Results:
Cylinder reduced from 0.92 ± 0.34 D to 0.14 ± 0.23 D. 95.8% achieved ≤0.50 D residual cylinder; 90% achieved UDVA ≥20/30; stable at 12 months; no complications.

Conclusions:
FLAK is safe and effective for mild–moderate astigmatism correction and establishes reference outcomes for Cassini-guided arcuate planning.

2019 – Cui et al. – Comparison of Keratometric Measurements Between Color LED Topography and Scheimpflug Camera
Purpose:
To determine the agreement of keratometric measurements—including corneal power, astigmatism, and axis on both anterior and posterior corneal surfaces—between the Cassini color LED topographer and the Pentacam HR Scheimpflug camera in healthy cataract surgery candidates.

Methods:
Retrospective study of 117 right eyes from 117 patients scheduled for cataract surgery. Steep K, flat K, mean K, astigmatism magnitude, and axis for both anterior and posterior corneal surfaces were measured with Cassini and Pentacam HR. All keratometric values were also converted into vector components (J0 and J45). Mean differences between devices were compared, and agreement was evaluated using Bland–Altman plots and intraclass correlation coefficients (ICC).

Results:
On the anterior surface, small but statistically significant differences were found in mean K and astigmatism between Cassini and Pentacam (mean Cassini–Pentacam difference ≈ 0.08 D for mean K and

0.11 D for astigmatism). On the posterior surface, flat K, mean K, and astigmatism also showed small but significant differences, with mean Cassini–Pentacam differences around −0.08 D to 0.07 D. Bland–Altman analysis showed narrow limits of agreement in dioptric terms, but the authors highlighted that systematic tendencies exist. ICC values for anterior steep K, flat K, mean K, and J0 exceeded 0.9, indicating excellent correlation, and positive correlations were observed for key parameters on both anterior and posterior surfaces ($P < .001$ for most metrics).

Conclusions:
Cassini tends to yield slightly higher corneal refractive power and astigmatism values than Pentacam HR in both anterior and posterior cornea, although correlations are strong. Because of these small but consistent differences, the two devices should not be considered interchangeable for keratometry and astigmatism, especially when precise toric IOL planning is required. Consistent use of a single device is recommended for biometric calculations and surgical planning.

2020 – Masiwa & Moodley – Review of Corneal Imaging in Preclinical Keratoconus
Purpose:
To summarize modern corneal imaging approaches for detecting early keratoconus, including LED reflection technology.

Methods:
Literature review of Placido, Scheimpflug, OCT, epithelial thickness mapping, and LED multi-spot systems.

Results:
LED reflection topography highlighted as having strong ability to detect subtle anterior surface irregularities. Its role as a complementary technology to tomography emphasized.

Conclusions:
LED reflection contributes meaningfully to preclinical keratoconus screening and is an important adjunct in modern imaging pipelines.

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2020 – Mendes et al. – Posterior TCA with LED Topography
Purpose:
To evaluate posterior corneal curvature and total corneal astigmatism (TCA) using Cassini LED topography.

Methods:
Healthy eyes imaged with Cassini; posterior curvature, posterior astigmatism, and TCA calculated. Agreement with Pentacam posterior astigmatism assessed.

Results:
Cassini demonstrated high repeatability of posterior curvature. Posterior astigmatism measurements showed close agreement with Pentacam. TCA values reflected clinically meaningful differences compared to anterior-only astigmatism.

Conclusions:
Cassini accurately measures posterior corneal astigmatism and provides clinically relevant TCA values for toric planning.

2020 – Carreras et al. – Comparison of Standard and Total Keratometry with Three Technologies

Purpose:
To compare standard keratometry (K) and total keratometry (TK) values across three systems: IOLMaster 700, Cassini, and Pentacam HR, evaluating clinical interchangeability and toric planning relevance.

Methods:
Prospective comparative study including 94 eyes. Devices tested: (1) IOLMaster 700 (SS-OCT), (2) Cassini (multicolor LED + IR reflection), (3) Pentacam HR (Scheimpflug). Parameters included flat K, steep K, ΔK, TK1, TK2, ΔTK, and white-to-white (WTW). Statistics included repeated-measures ANOVA, Pearson correlation, and Bland–Altman plots. Figures showed inter-device LoA and correlation behavior.

Results:
IOLMaster measured significantly steeper K and TK values than Cassini and Pentacam ($p<0.001$). Cassini measured the highest astigmatism magnitude for both standard and total keratometry. Differences between devices reached >1.0 D in some cases. Bland–Altman plots showed wide limits of agreement across all technologies, especially for

TCA. Cassini produced significantly higher WTW values. Posterior corneal algorithm differences heavily influenced disagreement.

Conclusions:
IOLMaster, Cassini, and Pentacam show strong correlation but clinically significant measurement differences. Devices are not interchangeable for toric IOL calculations. Cassini provided robust total corneal astigmatism values but should be used consistently as the primary planning tool.

2021 – Mohamed et al. – Galilei G4 vs Cassini
Purpose:
To compare the repeatability and agreement of anterior corneal curvature measurements from Galilei G4 dual-Scheimpflug and Cassini.

Methods:
Repeated measurements acquired on both devices. Evaluated flat K, steep K, mean K, astigmatism magnitude, J0/J45. Agreement tested with Bland–Altman.

Results:
Both devices showed strong repeatability. Cassini provided slightly higher axis stability. Agreement good for mean K but limits of agreement indicated the devices cannot be interchanged.

Conclusions:
Cassini and Galilei both perform well, but measurement differences support consistent use of one device for surgical planning.

2021 – Kanclerz et al. – Developments in Topography/Tomography (Review)
Purpose:
To review evolving corneal imaging technologies including LED-based topography.

Methods:
Literature review of topography, tomography, and hybrid imaging.

Results:

Cassini LED reflection listed as a major innovation in anterior and posterior corneal measurement with strong performance in astigmatism mapping.

Conclusions:
LED topography is validated as a modern tool within multimodal corneal diagnostics.

2021 – Fernández-Rosés et al. – Color LED Reflection Topography: Validation of Equivalent Keratometry Reading (EKR) for IOL Power Calculation in Post-Myopic Excimer Surgery Eyes

Purpose:
To evaluate the accuracy of the equivalent keratometry reading (EKR) derived from Cassini color LED topography, combined with the standard Haigis formula, for intraocular lens power calculation in eyes with previous myopic excimer laser surgery, and to compare its performance with established no-history methods (Barrett True-K, Haigis-L, Shammas-PL, and Triple-S).

Methods:
Retrospective case series of 37 eyes with prior myopic LASIK/PRK that later underwent cataract surgery. All eyes had optical biometry and good postoperative visual acuity (≥ 20/40). IOL power was calculated using: (1) Cassini EKR + standard Haigis formula (with constants optimized for virgin eyes), (2) Barrett True-K (no-history), (3) Haigis-L, (4) Shammas-PL, and (5) Triple-S combined with Haigis. For each method, the mean prediction error (PE), median absolute error (MedAE), and proportion of eyes within ±0.25 D, ±0.50 D, ±0.75 D, and ±1.00 D of target were calculated. Repeated-measures ANOVA compared PEs across methods.

Results:
Haigis-L, Shammas-PL, and Barrett True-K produced significantly myopic mean PEs (different from zero, $P < .01$), whereas Cassini EKR + Haigis and Triple-S + Haigis yielded mean PEs not significantly different from zero, indicating reduced systematic bias. The MedAE values were approximately 0.34 D for Cassini EKR + Haigis and Barrett True-K, ~0.49 D for Haigis-L, ~0.48 D for Shammas-PL, and ~0.31 D for Triple-S + Haigis. Overall, repeated-measures ANOVA showed significant differences among the PEs of all methods ($P < .0001$), with Cassini EKR + Haigis performing comparably to the best no-history approaches and without requiring special constants beyond those used for virgin eyes.

Conclusions:
The combination of Cassini EKR with the standard Haigis formula provides refractive outcomes comparable to leading no-history formulas for IOL power calculation after myopic laser surgery, with minimal systematic bias. Cassini EKR offers a practical, device-based solution for post-refractive IOL planning that can integrate into existing workflows without recalibrating lens constants for altered corneal geometry.

Packer, 2023 – Cassini Guidance OR Efficiency
Purpose:
To compare workflow efficiency between Cassini Guidance and traditional ink marking for toric IOL alignment.

Methods:
Up to 50 eyes; measured total alignment workflow time (pre-op + intra-op).

Results:
Ink marking required 6:42 minutes; Cassini Guidance required 1:05 minutes; time savings of 5:37 minutes per case.

Conclusions:
Cassini Guidance significantly reduces OR time and eliminates subjective variability from manual marking.

2023 – Hazen – Ocular Registration Overlay for Toric Alignment
Purpose:
Evaluate ocular-registration–guided graphical overlay (Cassini Guidance) for toric IOL alignment.

Methods:
Compared overlay-based alignment vs traditional marking. Metrics: alignment accuracy, workflow time.

Results:
Overlay improved alignment precision and reduced dependence on manual marking. Demonstrated real-time registration stability.

Conclusions:

Cassini Guidance enhances alignment accuracy and improves surgical workflow efficiency.

2023 – Gabric – IOLMaster700 vs Cassini Ambient

Purpose:
To compare keratometry and total keratometry (TK) between IOLMaster 700 and Cassini Ambient.

Methods:
Eyes imaged sequentially on both devices. Metrics: flat K, steep K, mean K, TK, astigmatism magnitude/axis. Agreement measured with Bland–Altman.

Results:
Strong correlation for keratometry. TK values showed systematic offsets but consistent bias. Cassini Ambient provided stable posterior inputs.

Conclusions:
IOLMaster and Cassini Ambient show strong correlation but should not be used interchangeably for TK-dependent IOL calculations.

2023 – Donnenfeld – Prospective Evaluation of Femtosecond Laser Arcuate Incisions to Treat Low Corneal Astigmatism Using Cassini Ambient and Catalys

Purpose:
To evaluate the safety, efficacy, and predictability of femtosecond laser arcuate incisions for treating low levels of corneal astigmatism in cataract surgery patients, using Cassini Ambient measurements of anterior and posterior corneal astigmatism combined with the Catalys femtosecond laser and a customized Donnenfeld arcuate nomogram.

Methods:
Prospective series of 82 eyes (82 patients) with low preoperative corneal astigmatism (approximately 0.5–1.3 D range), undergoing cataract extraction with femtosecond laser arcuate incisions. Total corneal astigmatism was measured by Cassini Ambient preoperatively and at 1 and 3 months. Additional metrics included automated keratometry, IOLMaster 700 keratometry, and manifest/automated refraction. Arcuate incisions were created with Catalys cOS 6.0 based on Cassini Ambient total cylinder, with 80% depth, 90° incision angle, an 8-mm optical zone, and arc lengths stratified by baseline astigmatism.

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Uncorrected visual acuity (UCVA) and changes in both objective (Cassini) and refractive astigmatism were analyzed over time.

Results:
Mean preoperative total Cassini Ambient astigmatism was 0.87 ± 0.30 D overall, with subgroup means of approximately 0.55 D, 0.78 D, 1.01 D, and 1.28 D by increasing cylinder categories. Cassini-measured total astigmatism decreased to 0.64 ± 0.39 D at 1 month and to 0.48 ± 0.31 D at 3 months (both P = 0.0001), indicating a progressive and statistically significant reduction. Manifest astigmatism declined from 0.74 ± 0.47 D preoperatively to 0.40 ± 0.26 D at 1 month and 0.20 ± 0.25 D at 3 months (P = 0.0001 and P = 0.00001, respectively). Mean logMAR UCVA improved from 0.67 ± 0.32 preoperatively to 0.13 ± 0.13 at 1 month and 0.06 ± 0.10 at 3 months (both P = 0.00001). No significant laser-related complications were reported.

Conclusions:
Femtosecond laser arcuate incisions guided by Cassini Ambient total corneal astigmatism and a dedicated nomogram significantly reduce low-grade corneal and refractive astigmatism and are associated with substantial improvement in uncorrected visual acuity. Automated axis and magnitude registration from Cassini Ambient appears to enhance the precision and predictability of laser arcuate treatments in refractive cataract surgery.

2023 – Cornell – Residual Astigmatism of Toric Intraocular Lenses: Intraocular Aberrometry vs Topography-Based Iris-Registration FLACS Toric Marks

Purpose:
To compare residual refractive astigmatism after toric IOL implantation when alignment is guided by intraoperative aberrometry versus when guided by Cassini Ambient topography with iris registration linked to a femtosecond laser platform placing toric corneal marks.

Methods:
Retrospective series of 136 eyes one month after cataract surgery with toric IOL implantation by a single surgeon. All types of toric IOLs were included (standard monofocal toric, accommodating toric, EDOF toric, and trifocal toric). In 76 consecutive eyes, toric placement was guided by intraoperative aberrometry (Ab group) aiming for “no-rotation required” readings. In 60 subsequent eyes, toric alignment was guided by Cassini Ambient iris registration integrated with the Catalys

femtosecond laser, which placed toric corneal marks (CC group). Postoperative manifest refractions from optometrists were analyzed for residual astigmatism, and the proportion of eyes within ±0.50 D of refractive cylinder was compared between groups and by IOL subtype.

Results:
Across all toric IOL types, the Cassini-guided corneal mark group (CC) achieved ±0.50 D of residual astigmatism in 86.7% of eyes, compared with 75% in the aberrometry group. For multifocal toric IOLs, 90% of CC eyes versus 80% of Ab eyes were within ±0.50 D. For EDOF toric IOLs, 90.9% (CC) versus 73.7% (Ab) met the same cylinder target. Standard toric IOLs showed 76% vs 50% (CC vs Ab), and in the small accommodating toric subgroup, 100% vs 80% (CC vs Ab) were within ±0.50 D residual cylinder. Overall, Cassini-guided femtosecond marks were associated with consistently lower residual astigmatism across lens categories.

Conclusions:
In this single-surgeon series, toric IOLs aligned using femtosecond laser corneal marks with iris registration from the Cassini Ambient topographer resulted in less residual refractive astigmatism than toric alignment guided by intraoperative aberrometry. These findings support the value of Cassini-based topography and iris registration integrated with FLACS platforms for precise toric alignment and improved refractive outcomes.

2023 – Swanic – Cassini Topography: Topography of the 21st Century (Clinical Experience Article)
Purpose:
To describe practical clinical experience with the Cassini topography system in a high-volume cataract and refractive practice, emphasizing its advantages for keratometry, posterior corneal curvature analysis, and integration with Lenstar biometry.

Methods:
Narrative clinical report from a cornea and refractive surgeon using Cassini over several years in private practice. The article details Cassini's underlying technology—700 multicolored LEDs for anterior surface mapping plus infrared LEDs for posterior curvature—contrasted with Placido disc and Scheimpflug systems. The author reviews workflow, image quality checks, diagnostic outputs (keratometry, posterior

astigmatism, SRI/SAI, HOAs), and practical use cases such as detecting dry eye, evaluating irregular astigmatism, and planning premium IOLs.

Results:
The author reports that Cassini provides highly repeatable keratometry that matches well with Lenstar values while offering richer topographic and posterior corneal information than Placido-based devices. The system's quality metrics (centraton, focus, coverage, stability, posterior data capture percentage) help technicians immediately recognize and repeat poor-quality images. Honeycomb-style LED grid maps enable visual confirmation of data integrity and facilitate identification of tear-film related artifacts. Compared with Scheimpflug tomography, Cassini's reflection-based posterior corneal assessment is considered faster and less susceptible to motion artifacts, especially for small changes relevant to toric planning. In daily practice, Cassini is described as central to toric IOL selection, arcuate incision planning, and counseling of premium IOL candidates.

Conclusions:
From this clinical experience perspective, Cassini is portrayed as a "topography of the 21st century," providing a powerful combination of accurate keratometry, posterior astigmatism assessment, and intuitive diagnostics that enhance cataract and refractive surgery planning. Its integration with optical biometry and ability to highlight ocular surface issues is emphasized as a key contribution to better refractive outcomes and patient selection.

Snellenburg et al., 2024 – Cassini Topographer (Book Chapter)
Purpose:
To describe Cassini technology, principles, and integration into modern IOL calculation systems.

Methods:
Technical and clinical review covering LED reflection physics, anterior/posterior modeling, TCA calculation, and surgical workflow integration.

Results:
Establishes Cassini as a core diagnostic element in digital cataract workflows; emphasizes posterior corneal astigmatism detection.

Conclusions:

Cassini is a high-precision platform with clear advantages for toric planning and intraoperative execution.

2025 – Hazen - J-CALC) compared to 7 existing IOL formulae using 3 different keratometric devices

Purpose

To evaluate the refractive accuracy of a new IOL calculator (J-CALC) compared to seven different IOL formulae when using keratometric (K) values from three different diagnostic devices.

Methods

Single-center, retrospective, non-interventional study of 1267 eyes that previously underwent cataract surgery and had preoperative biometry with both 2nd and 3rd generation LED topography (Ambient and Cassini, Cassini Technologies, B.V.), and optical biometry (Lenstar 900; Haag-Streit) or SS-OCT (Argos, Alcon Vision LLC). J-CALC is based on the theoretical model of the eye and only uses 3 variables to perform IOL calculation. Mean prediction error (MPE) within ± 0.50D and ±1.00D and standard deviations were analyzed using data from 1M post op visit.

Results:

In 976 eyes (Group A) data were obtained from optical biometer (Lenstar 900); in 291 eyes (Group B) data was collected from SS-OCT (Argos). In Group A, MPE within ±0.50D was as follows: J-CALC 87.6%, Barrett (modified) 73.2%, H1 72.5%, Haigis 73.4%, HofferQ 68.6%, SRK/T 68.1% ($p<0.0001$). In Group B, MPE within ±0.50D was as follows: J-CALC 75.9%, Barrett 71.8%, H1 67.4%, Haigis 63.9%, HofferQ 60.8%, SRK/T 61.2% ($p=0.016$). Within Group B, Argos K values were also substituted with K values from 2nd and 3rd generation LED topography (Cassini). Using J-CALC, MPE within ±0.50D was 70.8% for 2nd generation Cassini and 74.2% for 3rd generation Ambient, a significant improvement of +3.4% ($p<0.0001$).

Conclusion:

J-CALC provided the highest percentage of predictive accuracy when compared to other IOL formulae, while outperforming them across all 3 keratometric device measurements. The Ambient Total K is more accurate than its predecessor and is comparable to Lenstar 900 and Argos biometers.

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2025 – Gayton – Ambient vs Argos Comparator Study

Purpose

To compare the accuracy of astigmatic outcomes based on direct anterior and total corneal astigmatism measurements from a point source LED topographer versus keratometric values captured by swept source OCT in eyes undergoing cataract surgery.

Methods

Retrospective, single surgeon, single site, non-interventional study of 161 eyes that underwent previous toric IOL implantation following cataract surgery with preoperative biometry measurements using an LED topographer (Ambient; Cassini Technologies, B.V.) and swept source OCT biometer (Argos; Alcon Vision LLC.). The Ambient LED topographer captures a direct measurement of the total corneal astigmatism, whereas the Argos SS-OCT biometer provides a predictive posterior corneal astigmatic value. Residual cylinder, prediction errors, manifest refraction, and UCDVA, BCDVA were collected at one month postoperatively.

Results

In 99 eyes (Group A) data were obtained with both LED topography and SS-OCT; in 62 eyes (Group B), only SS-OCT data were collected and results were, respectively: mean residual cylinder 0.36±0.45D vs 0.43D±0.31D (p=0.22); mean prediction error -0.33±0.31D vs –0.34±0.45D (p=0.79); BCDVA at ≥20/20, ≥20/30, ≥20/40 were 57%, 89%, and 100% for Group A vs 60%, 95%, and 98% for Group B (p=0.64). The percentage of eyes within 0.25D, 0.50D, and 0.75D were respectively measured as: 55.6%, 83.8%, and 95.7% in Group A vs 43.6%, 82.3%, and 91.9% in Group B. Within Group A, analysis of flat K values demonstrated that Ambient had lower SD vs Argos (1.78 vs 1.96) was statistically significant. (p=0.0029).

Conclusion

Results suggest that clinical astigmatic outcomes of Ambient LED topography are comparable to Argos SS-OCT biometry for toric IOL power calculation. However, the Ambient demonstrated significantly greater precision in measuring keratometric values compared to the Argos when measuring the same eyes.

2025 – Wiley – Comparison of IOL Master 500, Ambient, and ORA

Purpose

To evaluate the post-operative refractive outcomes of optical biometry, LED topography, and intraoperative aberrometry techniques in surgical planning following cataract surgery.

Methods

This study is a single-center, retrospective, non-interventional, observational study of 21 eyes who previously underwent cataract surgery and had a preoperative measurements with an optical biometer (IOL Master 500, Carl Zeiss AG), LED topographer and guidance (Ambient and Connect; Cassini Technologies, B.V.), in addition to live intraoperative aberrometry (IA) (ORA; Alcon Vision, LLC). The primary endpoint was the percentage of eyes with MRSE ≤0.50D. Secondary endpoints included back-calculated post-operative spherical equivalent and residual cylinder (using the preop corneal power), mean predictive errors, and best corrected distance visual acuities were recorded.

Results

Data pool screening resulted in collection of 21 eyes in total with 1 month post op measurements. Following ORA recommended IOL power implantation, manifest refraction spherical equivalent (MRSE) was -0.41±0.54D (mean±SD) with 76% of eyes ≤0.50D. Mean residual cylinder was 0.36D±0.42D, and BCDVA at ≥20/20, ≥20/30, ≥20/40 were 67%, 90%, and 95% respectively. For back calculation, we replaced IA cylinder power with the preoperative planned cylinder power taken from either LED topography or optical biometry. Analysis of the residual cylinder with this method revealed the following percentages for residual cylinder ≤0.50D: 86% for Ambient, 81% for IOL Master 500; compared to 86% for ORA.

Conclusion

Results from this pilot study could suggest that clinical astigmatic outcomes of IA may be comparable to LED topography under surgical guidance, with both trended towards improved outcomes, however statistical significance was not achieved. A prospective study approach with larger sample size is required to draw definitive conclusions.

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