

BESSt® 2.0 IOL Power Calculator - REFERENCE GUIDE

Introduction

BESSt® 2.0 IOL Power Calculator was designed to allow more accurate corneal and IOL power estimation in eyes needing either cataract or clear lens surgery after Laser Refractive Surgery. As its predecessor BESSt 1.0, BESSt 2.0 formula is based on an improved version of the Gaussian Optics (or Thick Lens) Formula⁴ but it also includes several important new adjustments that make it significantly more accurate than BESSt 1.0 in post-hypermetropic treatments and make it more accurate than the other methods currently available. The main advantage of BESSt formula over other techniques is that it does not require *any* pre-refractive surgery information.

The results of BESSt 1.0 formula have been published in the Journal of Cataract and Refractive Surgery (J Cataract Refract Surg 2006; 32:2004–2014) and have been presented at several international Meetings. To learn more on BESSt 2.0 formula accuracy and see how it performs better than the other methods, please visit the website www.besstformula.com.

Hardware and Software Requirements:

- Operative system supported: Windows XP, Vista and Windows 7.
- No Mac or Linux versions are currently available.
- The software requires minimal hardware specifications and just a few megabytes of HDD space. Faster processors and more memory are however recommended to enable faster IOL Power graphs processing.
- To perform calculations using BESSt formula, an OCULUS Pentacam rotating Scheimpflug camera is required (either the standard or the HR model).
- A device to measure Axial Length is required. We recommend the use of the Zeiss IOL Master for greater accuracy.
- OPTIONAL: to print the results as PDF files (ideal to archive them as electronic records) you will need to have a PDF file creator software installed on your computer. Several freeware programs are available on the net for this purpose.

DISCLAIMER OF RESPONSIBILITY:

- **This program is not FDA approved for the use in the USA.**
- **BESSt 2.0 IOL Power Calculator is merely intended to be an aid for IOL power calculation after refractive surgery, but the choice of Intra Ocular Lens (IOL) to implant in the eye is ultimately the sole responsibility of the Surgeon performing the operation and EB Eye shall not bear any responsibility for any harm or damage (economical or of other nature) this choice might cause.**
- **BESSt Formula was calibrated using Anterior and Posterior radii of curvature of the cornea, Central Corneal Thickness and Spherical Aberration as measured with the Oculus Pentacam™ and Axial Length as measured with the IOL Master®. Calculation accuracy is not guaranteed should other instruments be used to perform these measurements. There is currently no published data on the reproducibility of measurements between different Pentacam™ units.**
- **Each License will allow the use of this program on a single Personal Computer (the one for which you have provided us with the Site Code).**
- **Registration through the website www.besstformula.com is necessary to activate the program (this applies to both the Trial and the Full License). Detailed installation instructions can be found in the “Download” and “FAQ” areas of the website.**

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- Pentacam™, Oculus™
- Hoffer™ Ridge Lens Corporation 1989-2009
- SRK®/T is a trademark of CTI (Computational Technology Inc.)

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1) DESCRIPTION OF FUNCTIONS AVAILABLE

BESSt 2.0 Formula: This new improved algorithm allows more accurate IOL power prediction in eyes which previously underwent Myopic or Hyperopic Laser refractive surgery (e.g. PRK, LASEK, Epi-LASIK, LASIK, Femtosecond LASIK etc..) compared to BESSt 1.0 and other methods.

BESSt 1.0 Formula: The old formula (still useful to estimate True Corneal Power following laser ablation) is still available, but now it must be used only in those rare cases in which you don't know whether the eye has had a laser refractive treatment for Myopia or for Hypermetropia.

BESSt_vc Formula for Virgin Corneas (no previous surgery):

This formula is experimental and we recommend you use it only in the very unlikely event that you do not have any other instrument but the OCULUS Pentacam to measure corneal power in eyes that need cataract surgery and have never undergone any kind of surgery. This formula is based on a regression analysis that predicts IOL Master equivalent K readings from Anterior and Posterior corneal radius measurements taken with the Pentacam.

3rd Generation formulas including HofferQ and SRK/T: The software includes the correct versions of the most widely used 3rd Generation formulas. This includes the correct version of the SRK/T formula and the most updated version of the HofferQ formula (taking into account the errata published in 1994 and the one from January 2007 on the JCRS). The implementation of both formulas in our software has been approved by their respective authors.

Off-line biometry directly from your laptop: If installed on your laptop or theater-PC, the program can also become an Excellent tool to repeat or simply double check your IOL power calculations in theater at the last minute even for standard cases (e.g. not post-laser refractive surgery) when a different lens or a different target refraction becomes necessary.

Double-K adjustment after laser refractive surgery: If for any reason you choose to use standard 3rd Generation Formulas rather than BESSt 2.0 to estimate IOL power after laser refractive surgery, we recommend that at least you use the Aramberry's Double-K adjustment to limit the possible postoperative refractive surprises. Double-K adjustments are available with the refraction calculated either at the Corneal (cp) or Spectacle (sp) plane. Some authors recommend the use of the Spectacle plane value to reduce the risk of ending up hypermetropic. The double-K adjustment can be applied to both the SRK/T and HofferQ formula.

Real time IOL Power prediction plotting for any desired biometry formula:

This unique feature allows real time plotting of IOL Power for any desired combination of parameters and using any desired formula (Figure 1). These graphs allow you to immediately identify those not-so-rare cases in which the formula chosen for biometry is likely to be inaccurate (e.g SRK/T formula in cases with very steep corneas such as after keratoplasty or in keratoconus) or when striking differences are present between different formulas.

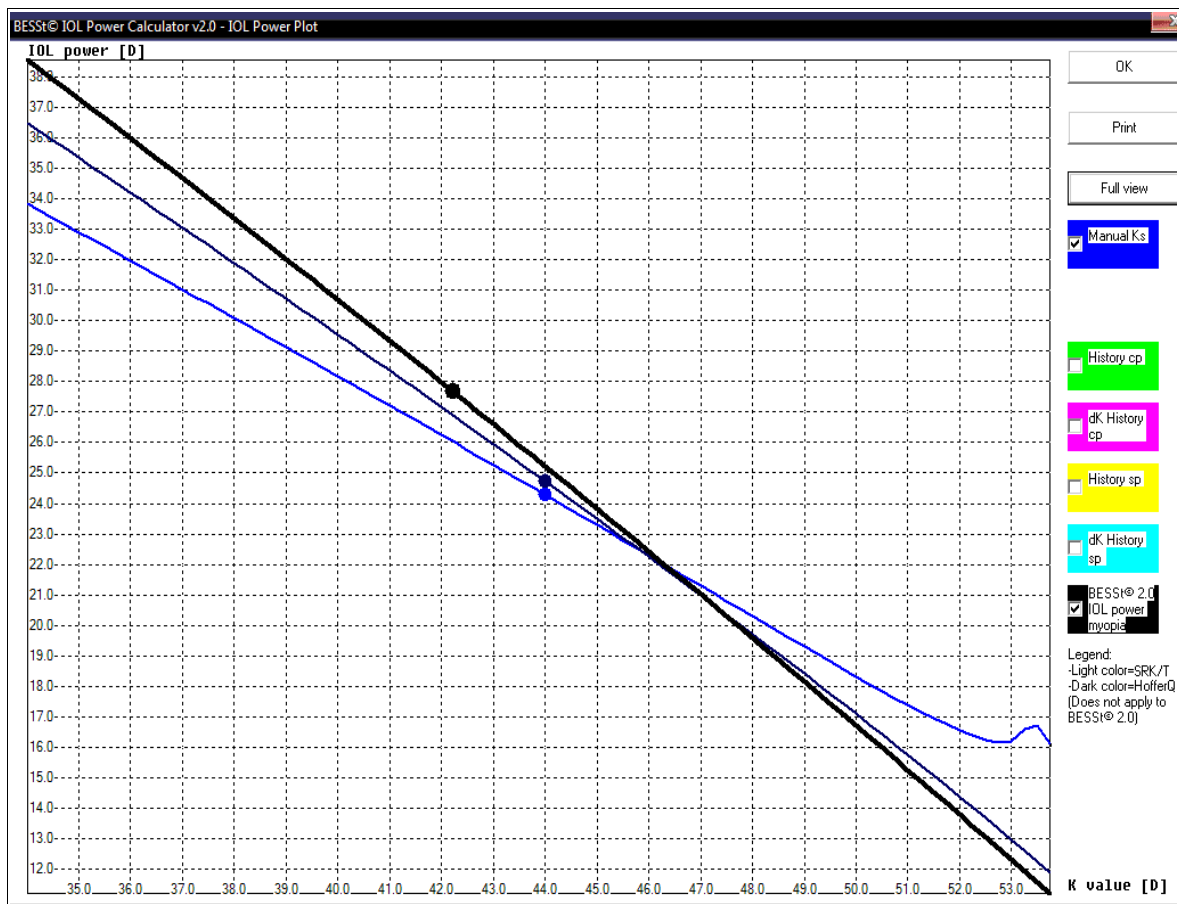


Figure 1. BESSt 2.0 IOL Power Calculator - IOL Power plotting.

Warning messages with automatic detection of the SRK/T formula's "Zero Argument" and "Cusp" phenomena:

This advanced function present in the software automatically detects those cases in which this formula yields incorrect results due to the occurrence of either the "Zero Argument" or the "Cusp" phenomenon.

SRK/T formula's Zero Argument (or Negative Square Root) phenomenon:

For certain combinations of AL and K readings (or anterior corneal radii), and most frequently for very steep corneas (such as post-corneal transplant), the formula as it was published yields an error and would not allow the calculation to be performed (Figure 2). This happens when the argument of the square root in the Estimated ACD equation [$ACD_{est} = ACD_{const} - 3.336 + r - \sqrt{r^2 - Cw^2/4}$] becomes negative. With reference to the figure below, all the area of the curve indicated by the asterisk can not be calculated when this occurs.

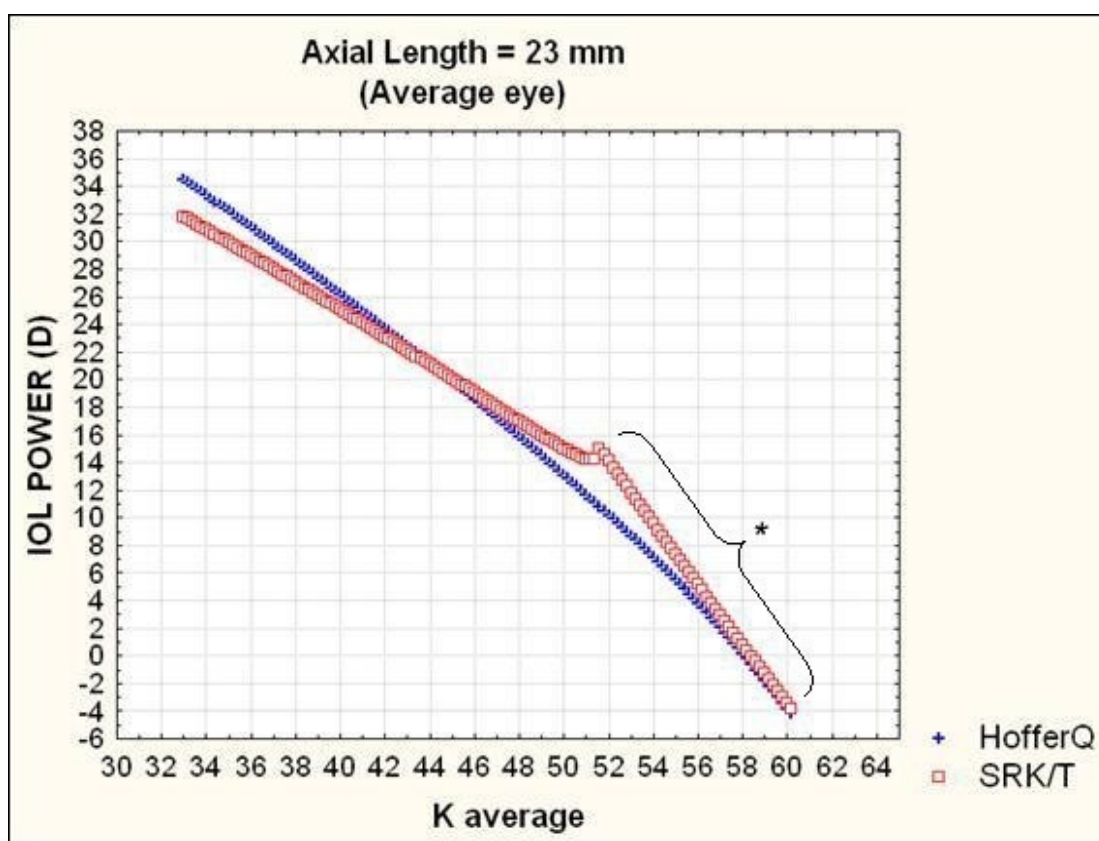


Figure 2. SRK/T's Zero argument (or negative square root) phenomenon of the SRK/T formula.

In the IOL Master this problem was addressed in order to return a result in any case. However, this is achieved by assigning the value zero to the argument of the square root of the Estimated ACD equation in all the cases when such value is a negative number. This allows a result to be displayed but generates inaccurate IOL power values in these cases. Our software automatically warns the user when this phenomenon occurs and advises to use alternative formulas (such as the HofferQ) in those cases.

SRK/T formula's Cusp phenomenon:

The cusp phenomenon is a consequence of the zero argument problem and consists in a sharp increase of the estimated IOL power (hence the term “cusp”), which is likely to result in serious refractive errors (Figure 3). The following are the combinations of AL and K values which are at greater risk of incurring into this problem: AL < 22 mm and K > 52.5; AL 22-24 mm and K > 49.5; AL > 24 mm and K > 48.3. Again, the software automatically warns the user when this happens.

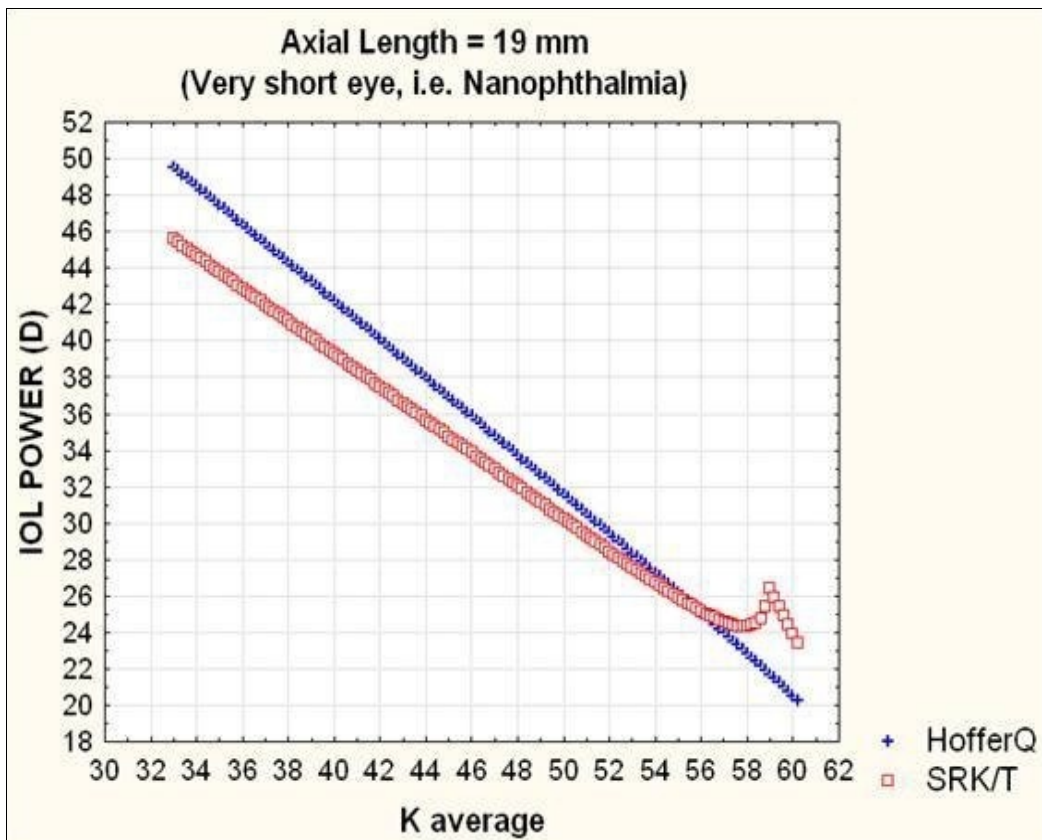


Figure 3. Cusp phenomenon of the SRK/T formula.

Calculation Printout:

The printout page shows IOL power calculations using the chosen formulas (Figure 4). The results are displayed in 0.50 D increments and range +/- 3.00 D from the desired Target Refraction. The program shows the actual value of the IOL power required to achieve the Target Refraction (e.g. 22.68 D), rather than the value rounded to the nearest 0.50 D increment (e.g. 23.00 D). The printout also displays information on Pentacam values, pre- and post-refractive surgery K values and Refraction.

```

BESSt IOL Power Calculator v2.0.0.36

SURNAME: Example      NAME: Patient      HOSPITAL No: 0000000001 DATE OF BESST COMPUTATION: Fri Jul 24 13:16:02 2009
A Constant IOL: 118.42      Target Refraction: -0.25      AL: 22.12

Pentacam - Post-refractive surgery -> CCT: 476, Ant r: 7.82, Post r: 6.32, Sph Aberr: 1.423
Pre-refractive surgery data -> K1: 45.25, K2: 44.75, Sph: -3.75, Cyl: -1.25, BVD: 12.50
Post-refractive surgery data -> Sph: -0.25, Cyl: -0.50

RIGHT EYE.      This eye has had laser refractive surgery for MYOPIA.

Corneal Power      Manual Ks      BESSt      History_cp      History_sp      Double-K cp      Double-K sp      BESSt 2.0 IOL MYOPIA
42.68              N/A           N/A           41.98           41.13           N/A             N/A

Target Refraction  SRKT   HofferQ    SRKT   HofferQ    SRKT   HofferQ    SRKT   HofferQ    SRKT   HofferQ    SRKT   HofferQ
+2.75            21.90  22.55     N/A    N/A         22.65  23.46     23.55  24.55     23.67  23.90     24.86  25.12     22.77
+2.25            22.64  23.31     N/A    N/A         23.37  24.20     24.26  25.19     24.42  24.66     25.61  25.93     23.55
+1.75            23.36  24.03     N/A    N/A         24.09  24.94     24.97  26.01     25.16  25.40     26.34  26.61     24.32
+1.25            24.07  24.78     N/A    N/A         24.79  25.66     25.66  26.73     25.89  26.13     27.07  27.34     25.07
+0.75            24.77  25.50     N/A    N/A         25.48  26.37     26.34  27.43     26.40  26.85     27.78  28.05     25.81
+0.25            25.46  26.20     N/A    N/A         26.16  27.07     27.01  28.12     27.31  27.94     28.48  28.76     26.54
-0.25            26.14  26.89     N/A    N/A         26.83  27.76     27.67  28.80     28.00  28.26     29.16  29.45     27.26
-0.75            26.80  27.58     N/A    N/A         27.49  28.44     28.32  29.47     28.68  28.95     29.84  30.13     27.97
-1.25            27.46  28.25     N/A    N/A         28.14  29.10     28.96  30.13     29.35  29.62     30.50  30.80     28.66
-1.75            28.11  28.91     N/A    N/A         28.77  29.76     29.59  30.78     29.91  30.29     31.16  31.46     29.35
-2.25            28.74  29.56     N/A    N/A         29.40  30.40     30.21  31.42     30.46  30.94     31.80  32.11     30.02
-2.75            29.37  30.20     N/A    N/A         30.02  31.04     30.82  32.05     31.30  31.99     32.44  32.75     30.68
-3.25            29.99  30.83     N/A    N/A         30.63  31.66     31.42  32.67     31.93  32.22     33.06  33.38     31.34

Warning(s):
Note: BESSt 2.0 Formula accuracy in eyes after MYOPIC laser refractive surgery (SEQ up to -11.63 D):
- Mean error: -0.05 ± 0.83 D SD.
- Max error: 1.41 D (Hyperopic outcome).
- Min error: -1.66 D (Myopic outcome).
- Therefore, if you want to be almost absolutely sure to avoid a hyperopic outcome and don't mind ending up myopic (up to ~ -3.00 D) you should increase the BESSt 2.0 IOL power by 1.40 D.

Manual Note:
    
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Figure 4. BESSt 2.0 IOL Power Calculator - IOL Power calculation printout.

IOL Power Plot Printout:

The IOL Power graphs generated with the Plot function can be printed either on traditional paper or as PDF files. To avoid confusion with too many curves simultaneously on the graph, only the ones selected in the Plot Window will be shown on the final printout (Figure 5).

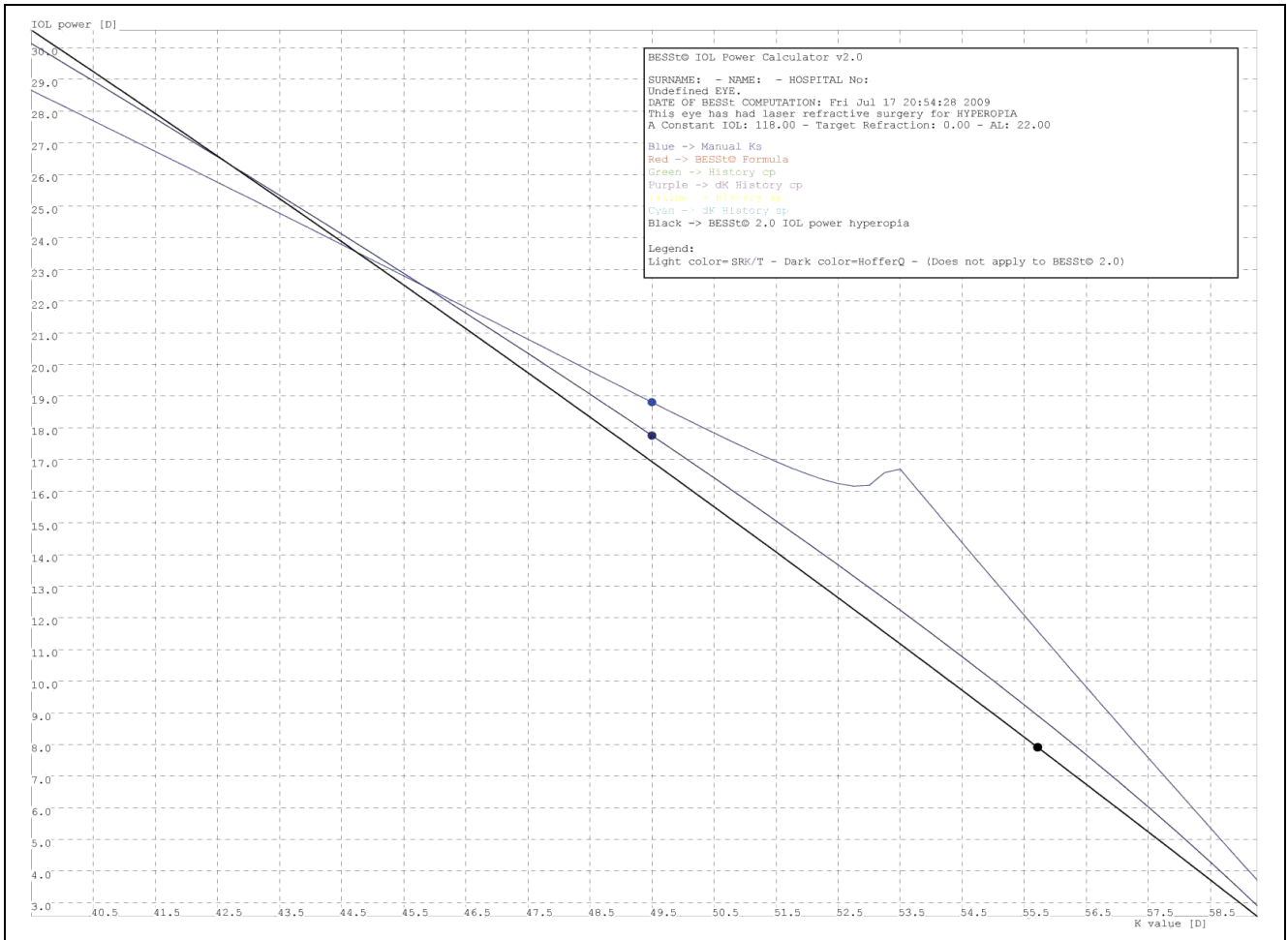


Figure 5. BESSt 2.0 IOL Power Calculator - IOL power plot printout.

Import/Export function to calculate large datasets at once:

This extremely powerful function allows importing large datasets from any program able to handle .CSV (Comma Separated Values) files such as Microsoft Excel™ or Open Office™. Once you have imported all the values from the .CSV file into BESSt 2.0 IOL Power Calculator, all the records will be calculated and the results exported in another .CSV file that can be edited for further statistical analysis or to create graphs (Figure 6). This is all performed with a simple click of the mouse, making BESSt 2.0 IOL Power Calculator the ideal tool for scientific research.

Surname	Name	Hosp No	Eye	Date & Time	CCT	Ant r	Post r	AL	Ks	Kf	Cornea State	Target	A Constant	Id
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:37:09 2006	476	8.75	6.51	25.00	39.25	40.00	Prev Refr Surg	-0.25	118.00	0
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:37:30 2006	476	8.75	6.51	25.00	39.25	40.00	Prev Refr Surg	-0.25	118.00	1
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:38:08 2006	476	8.75	6.51	25.00	39.25	40.00	Prev Refr Surg	-0.25	118.00	2
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:38:21 2006	476	8.75	6.51	25.00	39.25	40.00	Prev Refr Surg	-0.25	118.00	3
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:38:28 2006	476	8.75	6.51	25.00	39.25	40.00	Prev Refr Surg	-0.25	118.00	4
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:38:37 2006	476	8.75	6.51	25.00	39.25	40.00	Prev Refr Surg	-0.25	118.00	5
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:38:51 2006	476	8.75	6.51	25.00	39.25	40.00	Prev Refr Surg	-0.25	118.00	6
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:39:23 2006	476	8.75	6.51	25.00	41.00	40.00	Prev Refr Surg	-0.25	118.00	7
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:39:52 2006	476	8.75	6.51	25.00	41.00	40.00	Prev Refr Surg	-0.25	118.00	8
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:40:13 2006	476	8.75	6.51	25.00	41.00	40.00	Prev Refr Surg	-0.25	118.00	9
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:40:41 2006	476	8.75	6.51	25.00	41.00	40.00	Prev Refr Surg	-0.25	118.00	10
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:41:01 2006	476	9.12	6.51	25.00	41.00	40.00	Prev Refr Surg	-0.25	118.00	11
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:41:20 2006	476	8.84	6.51	25.00	41.00	40.00	Prev Refr Surg	-0.25	118.00	12
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:41:50 2006	476	8.84	6.51	25.00	41.12	40.00	Prev Refr Surg	-0.25	118.00	13
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:45:16 2006	476	8.84	6.51	19.00	41.12	40.00	Prev Refr Surg	-0.25	118.00	14
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:45:28 2006	476	8.84	6.51	19.00	41.55	41.00	Prev Refr Surg	-0.25	118.00	15
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:45:41 2006	476	7.55	6.51	19.00	41.55	41.00	Prev Refr Surg	-0.25	118.00	16
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:47:04 2006	476	6.66	6.51	19.00	41.12	40.00	Prev Refr Surg	-0.25	118.40	17
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:47:12 2006	476	6.66	6.51	19.00	44.00	42.00	Prev Refr Surg	-0.25	118.40	18
XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXX	RE	Sat Sep 09 11:47:30 2006	555	7.02	6.78	32.00	44.00	42.00	Prev Refr Surg	-0.25	118.40	19

Figure 6. BESSt_import.csv file.

Print on pdf:

You can easily save the Calculation Results Printout or the IOL Power Plot Printout in PDF format. This is ideal if you want to send the results by email or if you want to file them in an electronic record. This option requires that you have a PDF file creator software installed on your computer. Several free-ware programs are available on the internet for this purpose.

Keyboard Short Cuts:

- Ctrl + N = Perform a (N)ew calculation
- Ctrl + R = (R)ecalculate an entry changing some input variables
- Ctrl + G = Plot a (G)raph of the IOL power curve
- Ctrl + P = (P)rint results
- Ctrl + S = (S)how results
- Ctrl + I = (I)mport data from .csv file
- Ctrl + E = (E)xpport the calculated results onto a .csv file

2) HOW TO PERFORM A CALCULATION

File / Perform New Calculation

Keyboard Shortcut: Ctrl + N

STEP 1: CHOOSE THE APPROPRIATE FORMULA

The Corneal Status of the eye for which the calculation is about to be performed must be selected from the drop-down menu. The options available are:

- Previous laser refractive surgery for MYOPIA (BESSt 2.0 MYOPIA Formula)
- Previous laser refractive surgery for HYPERMETROPIA (BESSt 2.0 HYPERMETROPIA Formula)
- Previous laser refractive surgery – unsure if for Myopia or Hypermetropia (BESSt 1.0 Formula)
- This eye has never had refractive surgery (BESSt_vc Formula)

The selection of the correct Corneal State is of **critical importance**, since a different formula (the one within brackets) will be applied depending on your selection: the new and more accurate **BESSt 2.0 MYOPIA Formula** will be used in eyes which have undergone laser refractive surgery for myopia; the new and more accurate **BESSt 2.0 HYPERMETROPIA Formula** will be used in eyes which have undergone laser refractive surgery for hypermetropia; the old **BESSt 1.0 Formula** will be used in eyes which have undergone laser refractive surgery when you are unsure whether they were originally myopic or hyperopic; **BESSt_vc Formula** will be used in eyes which have never undergone laser refractive surgery (remember that this last formula is still experimental).

STEP 2: CHOOSE THE TARGET REFRACTION, AXIAL LENGTH, A-CONSTANT

The desired post-operative Target Refraction (expressed in Diopters), the eye's Axial Length (expressed in mm), and the A-Constant of the IOL to be implanted must be entered in the appropriate fields. For greater accuracy, we recommend measuring Axial Length with Partial Coherence Interferometry (PCI) devices such as the IOL Master™ and using Customized A-Constant values rather than the labeled ones. Instructions on how to customize the A-Constants for the IOLs you use more frequently are available on the internet. A minimum of 10 eyes is required and the customization process is very simple if you are doing it with the IOL Master.

STEP 3: ENTER THE OTHER INPUT VARIABLES

- You don't need to enter a value in all the fields. The values you need to enter depend on the formula you intend to use.
- To make a calculation using **BESSt formula (either 1.0, 2.0 or "vc")**: you need to enter all the values present in the PENTACAM FIELDS at the top of the calculation screen.
- To make a calculation using standard **3rd Generation formulae like HofferQ**: you need to enter a value in both the Manual K fields (you can take these values from the IOL Master or a corneal topographer or your choice).
- To make a calculation using the **Historical Method** with or without the **double-K adjustment (either at the corneal or spectacle plane)** applied to standard 3rd Generation formulae: you need to enter a value in all the OPTIONAL FIELDS at the bottom of the screen.
- When you press the CALCULATE button, the results will be displayed according to the inputs you have entered.

If you know that the eye has undergone a laser treatment for Myopia or Hypermetropia, please choose accordingly from the drop-down menu so that the new BESSt 2.0 algorithm can be used for greater accuracy. In fact BESSt 2.0 is actually two separate algorithms, one for Myopia and one for Hypermetropia. BESSt 2.0 can provide even more accurate results when the Spherical Aberration of the lasered eye is known.

Otherwise, if you are unsure about the refractive status of the eye, just choose this option from the menu so that the old (BESSt 1.0) algorithm will be used.

Here are some examples for each formula:

Using BESSt 2.0 Formula

To estimate IOL power following laser refractive surgery using BESSt 2.0 Formula, the following Oculus Pentacam™ inputs are required:

- CCT: Central Corneal Thickness (microns) [e.g. 563]
- Ant r (Rm): Anterior corneal radius of curvature (mm) [e.g. 7.29]
- Post r (Rm): Posterior corneal radius of curvature (mm) [e.g. 6.83]
- Sph Aberr: Spherical Aberration [e.g. 0.146]

You can find the first 3 values (CCT, Ant r, Post r) in the **Pentacam’s Refractive View** (Figure 7) of the laser treated eye. The values to be used are the ones highlighted in blue in the image below. For Ant r and Post r, you have to use the Cornea Front “Rm” and Cornea Back “Rm” values, respectively.

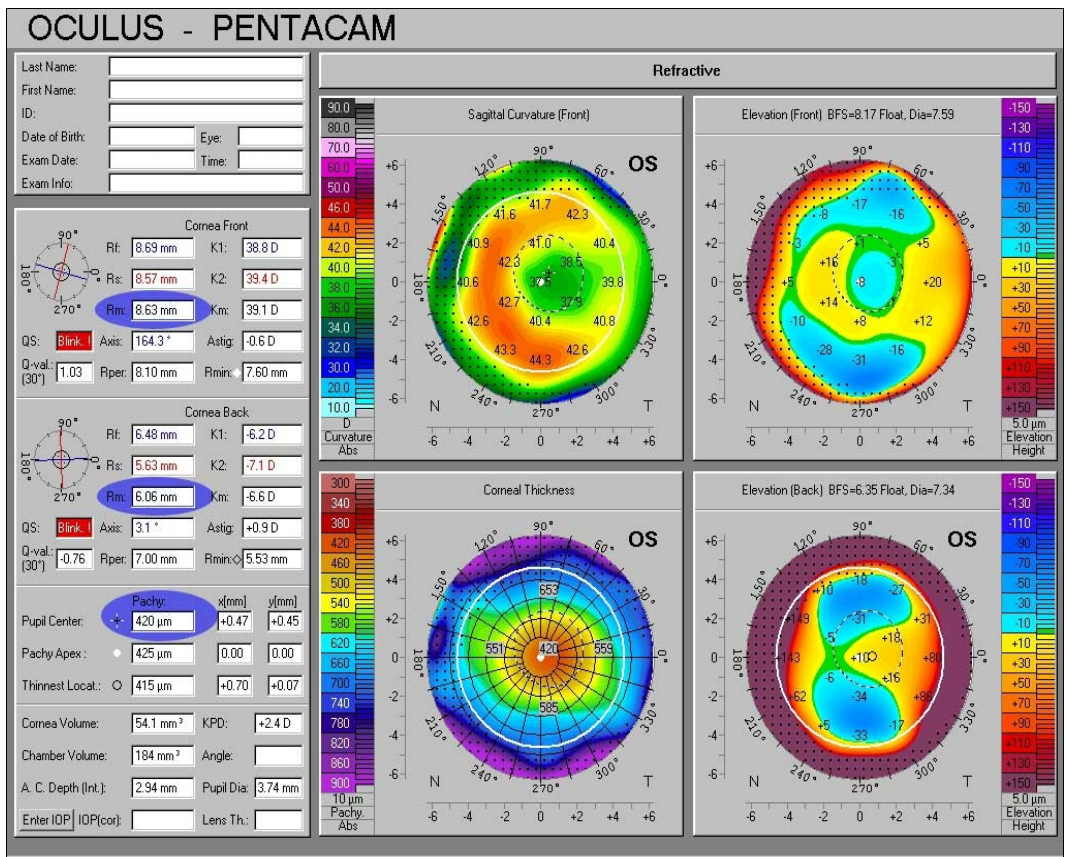


Figure 7. Pentacam’s Refractive View

IMPORTANT NOTE: corneal curvature measurements taken with other instruments (such as the Orbscan) are not supported and may lead to serious refractive errors as BESSt 1.0, BESSt 2.0 and BESSt_vc formulas originate from very fine tuning and regression analysis based on measurements taken only with the Oculus Pentacam.

The last value, Sph Aberr, can be retrieved from the **Zernike Analysis View** of the Pentacam (Figure 8). This Spherical Aberration value corresponds to the Z (m=0; n=4) value, as highlighted in blue in the image above.

IMPORTANT WARNING! If the aberration feature is not available on your Pentacam unit, then please just enter 0 (zero) in the Spherical Aberration field. If you are not sure about this value you must enter zero (0) as a wrong value can greatly affect the computed BESSt 2 IOL power. We advise never entering values >2.50 or < -2.50.

Please note that the Sph. Aberr. value is used in the equation leading to the estimation of IOL Power as part of a regression formula rather than from a purely optical or ray-tracing point of view. So, use it with caution.

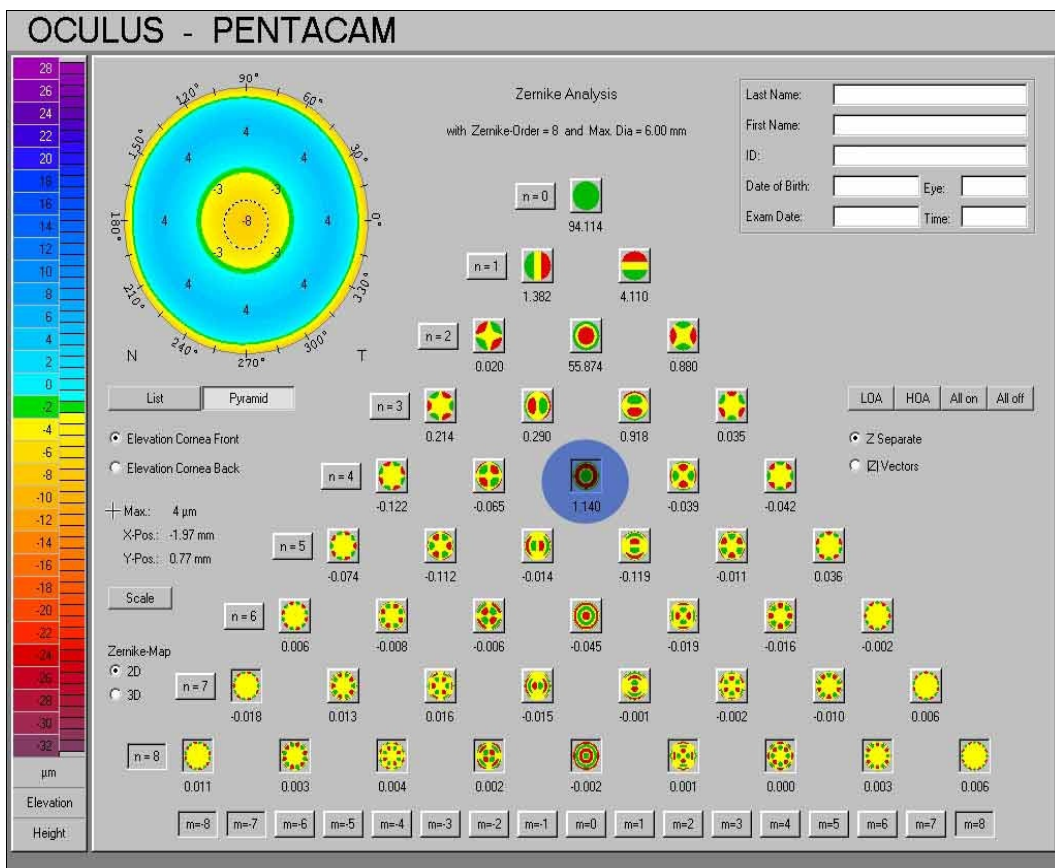


Figure 8. Pentacam’s Zernike Analysis View

Using BESSt 1.0 Formula

When you select this option you will notice that the Spherical Aberration field that was present while using BESSt 2.0 will disappear. This value in fact is not required with the old algorithm. The other values (CCT, Ant r, Post r) have to be entered exactly in the same way as explained above for BESSt 2.0 formula.

Using the K values of your choice with 3rd Generation formulas

If for comparison purposes you want also to display the results of 3rd Generation formulas simply using K values taken from a corneal topographer of your choice, you will have to fill in the Steep K and Flat K fields on the top-right hand corner of the calculation window.

Steep K: Steep corneal meridian (D) [e.g. 45.87]
 Flat K: Flat corneal meridian (D) [e.g. 45.12]

Using the Clinical History Method, with or without double-K Adjustment (Requires pre-refractive surgery data)

If you wish instead to estimate IOL power with more traditional methods such as the Clinical History Method with or without the double-K adjustment proposed by Aramberri and with the manifest refractions calculated either at the corneal (“cp”) or spectacle plane (“sp”), you will have to enter a values in all the “OPTIONAL FIELDS” located at the centre of the calculation window as shown below.

Pre-keratorefractive surgery data					Post-keratorefractive surgery data								
K1:	<input type="text"/>	K2:	<input type="text"/>	Sph:	<input type="text"/>	Cyl:	<input type="text"/>	BVD:	<input type="text"/>	Sph:	<input type="text"/>	Cyl:	<input type="text"/>

The Historical method, differently from BESSt formula, requires pre-refractive surgery information and needs a value to be entered in ALL the “OPTIONAL FIELDS”. Here is an example:

Pre-keratorefractive surgery data:

- K1: Steep corneal meridian before refractive surgery (D) [e.g. 45.87]
- K2: Flat corneal meridian before refractive surgery (D) [e.g. 45.12]
- Sph: Sphere (D) of Manifest Refraction [e.g. -4.25]
- Cyl: Cylinder (D) of Manifest Refraction [e.g. -1.25]
- BVD: Back Vertex Distance (mm)= from corneal apex to posterior surface of the lens. [e.g. 12.25]

Post-keratorefractive surgery data:

- Sph: Sphere (D) of Manifest Refraction [e.g. -0.75]
- Cyl: Cylinder (D) of Manifest Refraction [e.g. -0.50]

STEP 4: CALCULATION

Click on the **Calculate** button and the results will be displayed in the Results section of the window. Warnings and special notes, when triggered, will appear in the Notes section.

The button **“Clear All”** clears all the inputs as well as all the results and allows entering a new set of data. By doing so the record that has just been calculated will be replaced by the new one.

The button **“Clear Results”** clears only the results leaving the old inputs visible so that you can perform other calculations adjusting only selected parameters. By doing so the record that has just been calculated will be replaced by the new one.

The button **“Cancel”** allows you to go back to the main menu, from which you can perform a new calculation for the fellow eye of the same patient or for another patient.

3) HOW TO PRINT THE RESULTS

- Select the entry you desire by clicking in the Surname column.
- File / Print
- Keyboard Shortcut: Ctrl + P

Alternatively, if you have just finished performing the calculation and are still in the Calculation window you can just click on the “Print Results” button.

IMPORTANT NOTE: Landscape mode must be selected in order to fit all the results in the same page.

4) HOW TO GENERATE AN IOL POWER PLOT

Select the entry you desire by clicking in the Surname column.
File / Plot
Keyboard Shortcut: Ctrl + G

Alternatively, if you have just finished performing the calculation and are still in the Calculation window you can just click on the “Plot IOL Power” button.

5) HOW TO PRINT AN IOL POWER PLOT

Select the entry you desire by clicking in the Surname column.
File / Plot
Keyboard Shortcut: Ctrl + G

Then, once you are in the graph window, click on Print Plot.

IMPORTANT NOTE: Landscape mode must be selected in order to fit all the results in the same page.

6) HOW TO VIEW THE RESULTS OF A PREVIOUS CALCULATION

Select the entry you desire to view by clicking in the Surname column.
File / Show Results
Keyboard Shortcut: Ctrl + S

Select this option when you want to review the results of a calculation that you have already performed and don't wish to change any parameter. If you are using the Trial version, no calculation will be deducted using this option.

7) HOW TO VIEW THE IOL POWER PLOT OF A PREVIOUS CALCULATION

Select the entry you desire by clicking in the Surname column.
File / Plot
Keyboard Shortcut: Ctrl + G

8) HOW TO REPEAT A CALCULATION CHANGING SOME PARAMETERS (UPDATING AN EXISTING RECORD)

Select the entry you want to modify clicking in the Surname column.
File / Recalculate with the selected data
Keyboard Shortcut: Ctrl + R
Answer YES to the prompt message.

You can now modify all the values that you wish in the calculation interface. Once you press the button Calculate the calculation will be repeated and the record updated. **ATTENTION! With this option the inputs and the results of the old calculation will be permanently lost.**

9) HOW TO REPEAT A CALCULATION CHANGING SOME PARAMETERS (CREATING A NEW RECORD)

Select the entry you desire to modify by clicking in the Surname column.
File / Recalculate with the selected data
Keyboard Shortcut: Ctrl + R
Answer NO to the prompt message.

You can now modify all the values that you wish in the calculation interface. Once you press the button Calculate the calculation will be repeated and a new record will be created at the bottom of the database. **This option is safer than the previous one, since it will leave the original record unaffected.**

10) EXPLANATION TO NOTES AND WARNINGS:

In certain situations, some warnings may appear in the “Notes” fields in the bottom-left hand corner of the calculation window, to better help you choosing the most accurate IOL in all situations. Here are some typical warnings:

- **“NOTE: The difference between Ant r (Pentacam™) and K average (IOL Master™) is >0.50 D.”**

This note appears when the program detects a difference >0.50 D between the values entered manually in the Manual K fields and those ones that derive from the corneal Anterior radius of curvature as measured with the Oculus Pentacam™.

In virgin corneas, these values should not differ significantly from each other, whereas in post-refractive surgery eyes it is normal to find significant difference between the two and therefore the note will appear often.

If the note appears when you are making the calculation for a virgin cornea, just make sure you have entered the K and Ant r values correctly.

- **“WARNING: SRK®/T NEGATIVE SQUARE ROOT Phenomenon detected!”**

(A list of the formulae affected by this phenomenon follows)

For certain combinations of AL and anterior corneal radii (r), and most frequently for very steep corneas, the published SRK/T^{®5} formula yields an error and does not allow the calculation¹⁰. This happens when the argument of the square root in the equation below becomes negative. This phenomenon is also known as the “zero argument problem”.

$$1) \text{ ACDest} = \text{ACDconst} - 3.336 + r - \text{SQRT}(r^2 - Cw^2/4)$$

In the version of the SRK®/T Formula implemented in this software, similarly to the one implemented in the IOL Master™, this problem has been addressed, so that the software still returns a value also in these cases. This is achieved by assigning the value 0 to the argument of the square root of equation 1, in all cases where such value is negative. This can give rise to inaccurate IOL power calculations. In the rare event that you should come across this warning, it would be advisable to use other formulae instead of the SRK®/T to calculate IOL power.

- **“WARNING: SRK®/T CUSP Phenomenon detected!”**

(A list of the formulae affected by this phenomenon follows)

The SRK/T “cusp” is directly linked to the zero argument phenomenon described above and originates from particular combinations of AL and K values¹¹. This leads to very inaccurate estimation of IOL power.

Eyes with the following combinations of values are more likely to be affected by this phenomenon:

AL < 22	mm	and	K >52.5
AL 22-24	mm	and	K >49.5
AL >24	mm	and	K >48.3

In the rare event that you should come across this warning, it would be advisable to use other formulas instead of the SRK®/T to calculate IOL power. No solution to this phenomenon is described in the literature.

More details and graphs on these phenomena are available on the BESSt formula website.

USING THE IMPORT/EXPORT FUNCTION FOR STATISTICAL ANALYSIS

BESSt® 2.0 IOL Power Calculator allows easy import/export of data which is particularly useful when you wish to perform statistical analysis on large sets of data.

11) HOW TO IMPORT A DATASET

File / Database / Import (CSV)

Keyboard Shortcut: Ctrl + I

The following instructions show how to prepare the “BESSt_Import.csv” file in order for the data to be read and imported correctly into BESSt 2.0 IOL Power Calculator.

1. Find out the working directory where the “BESSt_Import.csv” file has automatically been created. The default directory is “C:/Program Files/BESSt” but it may be a different one if you have chosen another location during the setup.
2. Open the “BESSt_Import.csv” file with the program of your choice (e.g. Microsoft Excel™ or Open Office). If you open it using Open Office it should look similar to the one below:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q								
1	Surname	Name	HospNo	[RE][LE]	CornealState[VC]	PostR	CCT	microns	Ant r	Post r	SpA	SpB	AL	mm	K1	K2	Target	A-constant	PreRS	K1	PreBS	K2	PreB		
2	TestPatient1	VirginCorneaBESS1_vc	TestPatient1	RE	VC		530	7.7	6.05	0.12	25.23	43.27	43.5	-0.25	119.2										
3	TestPatient2	PostRefractiveSurgeryBESS1	TestPatient2	LE	PostRS		490	8.7	6.01	1.66	24.33	38.75	39.25	0	119.2										
4	TestPatient3	PostMyopicLaserBESS2	TestPatient3	RE	PostMyopicLaser		466	8.86	6.33	1.95	26.54	37.75	37.5	-0.5	118										
5	TestPatient4	PostHyperopicLaserBESS2	TestPatient4	LE	PostHyperopicLaser		530	7.5	6.35	0.45	22.12	45.5	46.12	-1.5	118.49										
6																									
7																									
8																									
9																									
10																									
11																									

As you can notice, the file already contains some values that have been inserted purely as an example to show you how the values have to be entered in order for the calculations to be performed with the formula of your choice (more explanations below). You can select all the rows below the first one (the one with the headings) and delete them if you wish, as they are there just as an example. We suggest practicing importing and exporting this file before practicing in a real environment.

3. Now the boring part: entering all the desired input values in the required columns. Depending on the formula used it may not be necessary to enter values in all fields. Read carefully the instructions below to avoid mistakes:

a. Eye:

- i. Type **RE** for the **Right Eye**
- ii. Type **LE** for the **Left Eye**
- iii. Type **Undefined** for **Undefined**

You should type all in UPPER CASE. This means that if you write “re” or “le”, this will NOT be recognized by the program and “Undefined” will appear in the Database.

b. Corneal State:

- i. Type **PostMyopicLaser** to use **BESSt 2.0 MYOPIA Formula**
- ii. Type **PostHyperopicLaser** to use **BESSt 2.0 HYPERMETROPIA Formula**
- iii. Type **PostRS** to use **BESSt 1.0 Formula**
- iv. Type **VC** to use **BESSt_vc Formula (experimental)**

c. Other variables

- i. They correspond to all the variables present in the Calculation window
- ii. The same measuring units have to be used

Here are some common mistakes to be avoided in order for the program to successfully read the file:

- Using quotation marks (“ ”) to enclose text or values.
- Spelling the EYE of CORNEAL STATE incorrectly (eg. PostRSX instead of PostRS).
- Leaving a crucial field (such as AL, Target Refraction, A-Constant) empty.
- Entering characters rather than values where values are needed.
- Entering values that are out of range.

Important notes:

- When entering data, extreme care must be taken not to change the headings of the different variables in the first row or the order of the columns in the spreadsheet. This will cause the variables not being imported successfully or being imported in the wrong fields.
- The import file name (BESSt_import) and extension (.csv) should NEVER be modified. The program can't import data stored in a different format.
- If you have inadvertently corrupted the Import file you can download a new one from the Download section of the website www.besstformula.com. Make sure you save it in the directory where you have installed the program (the default one is C:/Program Files/BESSt).

4. Once you have finished entering all the values, **you must save the file maintaining the .csv extension. Continue reading as this can sometimes be tricky!**

- If you are using **Microsoft Office Excel™** you must click on **Save as** and use the **Windows CSV** format. Saving with any other CSV format may make the file unreadable by our program! After clicking on Save, a prompt message may appear and you will have to click on “YES”. Then close Excel™ by clicking on the cross at the top right of the window. Another prompt window may appear asking if you want to save the changes made to the file. Click on “NO”.
- If you are using **Sun Microsystems™ Open Office** the procedure unfortunately is a bit more complex as for some reason Open Office automatically adds some quotation marks (“ ”) before and after each value without you realizing it. The quotation marks must be removed before the file can be read correctly by the BESSt calculator. Here is the procedure: first of all click on **Save as** and use the **Text CSV format**. Then **Close** the file and open it with **WordPad** or **Notepad** (you can right-click with the mouse and then select **Open With...**). You will notice that many quotation marks (“ ”) will be visible before and after each value (eg. “Mr White”). Now click on **Edit / Replace** and enter “ in the first field and leave the second field empty. Then click on **Replace All**. All the “ will disappear. Click on **Save** and **Close** the file. Now the file can be read correctly by the BESSt program.

5. The file is now ready to be Imported into BESSt© 2.0 IOL Power Calculator! Launch the program and click on File/Database/Import (CSV). A window will appear asking to confirm which entries you wish to import. Click “YES” if you want to import that entry, or “NO” if you want to skip it. If you have hundreds of entries just keep the Return key pressed and the process will be completed quicker. At the end of the import process all the desired entries should have been imported into the BESSt© 2.0 IOL Power Calculator database and you should be able to see them on the updated patients list.

6. If you now wish to calculate all the records you have imported, simply click on:

File / Database / Recalculate all entries

This function calculates all the records present in the database at once. You need to do so every time you import new data from a .CSV file before you can export it (with the calculated results) onto a BESSt_export.csv file.

12) HOW TO EXPORT A DATASET FOR STATISTICAL ANALYSIS

File / Database / Export (CSV)

Keyboard Shortcut: Ctrl + E

Exporting the results is much easier! After clicking on “Export (CSV)” a prompt message will appear asking you if you want to recalculate all the entries in the database. You must answer “YES”.

After you have answered to the prompt, a file called “BESSt_export.csv” will be created in the working directory of the program. The default directory is “C:/Program Files/BESSt” but it may be a different one if you have chosen another location during the setup.

VERY IMPORTANT NOTE: Once the export file is created, you should open this file immediately with the program of your choice (e.g. Excel™ or Open Office) and click on “Save As” in order to SAVE IT WITH A DIFFERENT NAME AND WITH THE STANDARD EXTENSION OF THAT PROGRAM (e.g. .xls for Excel™). You can now edit this file as you wish for further statistical analysis or to create graphs.

IF YOU DON'T RENAME THE FILE YOU HAVE EXPORTED, the next time you Export some data using BESSt© 2.0 IOL Power Calculator, another file named BESSt_export.csv will be created, overwriting the existing one and ALL DATA WILL BE PERMANENTLY LOST.

13) HOW TO EDIT A NOTE

File / Edit note

This function allows you to add a note of your choice that will appear in the calculation window, database column and BESSt_export.csv file.

14) HOW TO DELETE A RECORD

File / Delete entry

This function allows you to permanently delete a calculation record.

ATTENTION! This action can't be undone.

15) HOW TO IMPORT A BESSt1.0 DATABASE INTO BESSt2.0 IOL POWER CALCULATOR

After uninstalling the old program the old database will not be deleted but will become unreadable by the new software.

Therefore, if you wish to retain all your patient records you need to follow this simple procedure BEFORE UNINSTALLING THE OLD PROGRAM:

Launch the old program and click on “File / Recalculate All”; then click on “Database / Export Database”; close the program; notice that a file called “BESSt Export.csv” will be created in the working directory of the program (the default directory is “My Programs / BESSt”); make a copy of this file and keep it in a safe place just for extra safety; now uninstall the old program and install BESSt 2.0 in the directory of your choice; you will notice that a file called “Import.csv” will be automatically created in the working directory of BESSt 2.0; open this file with the program of your choice (you can either use Microsoft Excel™, Open Office or any another program able to handle .csv files); open also the “Export.csv” file that was created with BESSt 1.0 and arrange them so that you can view both side by side on the same screen; now it's time to manually copy and paste all the input values (not the outputs, as they will be recalculated) from the “Export.csv” file into the appropriate columns of the new “Import.csv” file; when copying and pasting the values make sure not to modify the first row which contains the headings; it is crucial that you specify the Corneal State correctly, depending on which formula you want to use for the calculation. Please refer to “10) HOW TO IMPORT A DATASET” for further advice; once done, save the file and close it (don't change the name or the extension of the file as BESSt 2.0 can only read .csv files and not standard Excel™ [.xls or .xlsx] files); now launch BESSt 2.0 and click on “Database / Import”; all the new records will appear in the database; click on “Recalculate all” and all the records will be automatically calculated with the formulas you have chosen in the Corneal State column of the “BESSt_import.csv” file.

16) HOW TO UPGRADE FROM THE TRIAL TO THE FULL LICENSE

Help / Upgrade License.

This function allows you to remove the Trial License in order to activate the Full one. After the Trial License has been removed you will have to re-launch the program and enter the Site Key of the Full version as issued by us.

17) HOW TO UPGRADE FROM BESSt1.0 to BESSt2.0

If you already have a Full License active on your PC, no further activation code is necessary. Just uninstall the old version and install the new one and you should be ok. Before uninstalling the old program read the important database compatibility issues “14) HOW TO IMPORT A BESSt1.0 DATABASE INTO BESSt2.0 IOL POWER CALCULATOR”.

We advise backing up the old database (BESSt_db) before uninstalling the old program just in case there is a problem. This file can be found in the working directory of the program, which by default directory is “My Programs/BESSt”.

IMPORTANT: Database file

Each time you close BESSt® 2.0 IOL Power Calculator, a database file (*BESSt_db*) will be created (or updated) in the installation directory (*C:/Program Files/BESSt* by default). This is a very important file which contains all patient information and the results of all the calculations performed so far. It is advisable to perform regular backups of this file because should it become corrupted or inadvertently deleted, all data would be irreversibly lost.

If you have inadvertently deleted the database file, a new one will be created the next time you launch the program, but all previous data will be lost.

18) REFERENCES

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- 10) Occurrence of erroneous anterior chamber depth in the SRK/T formula. Haigis W. J Cataract Refract Surg. 1993 May;19:442-3
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19) TECHNICAL SUPPORT

For technical support on the use of the program, please visit the “Technical Support” section of the BESSt formula website: www.besstformula.com.