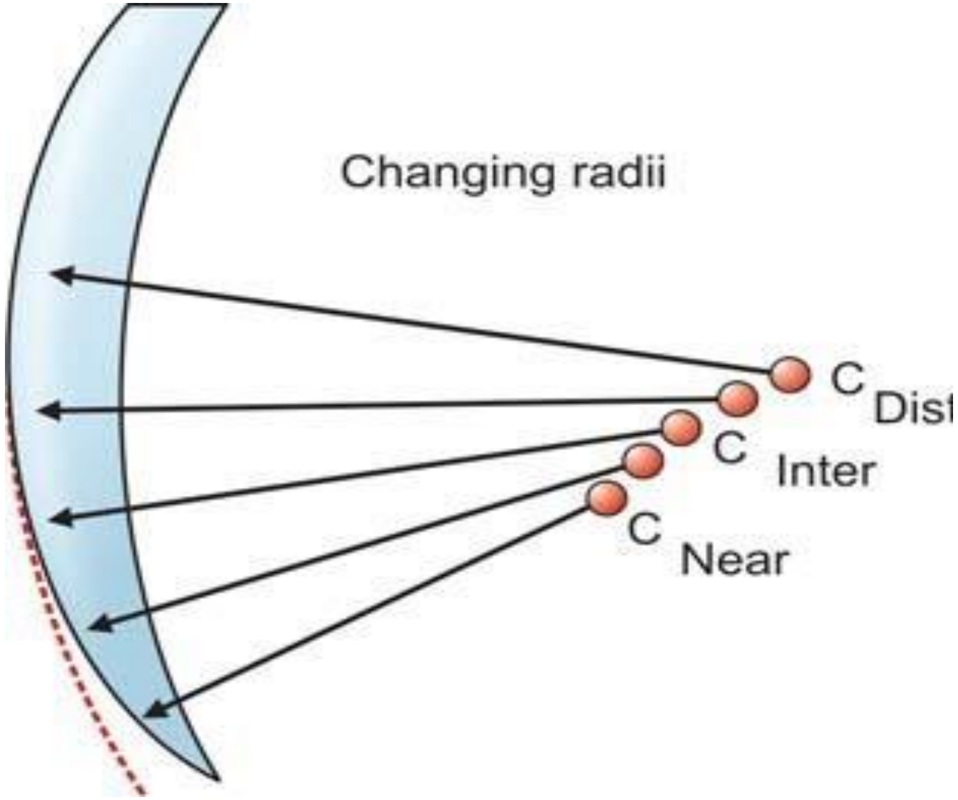
Progressive Addition Lenses

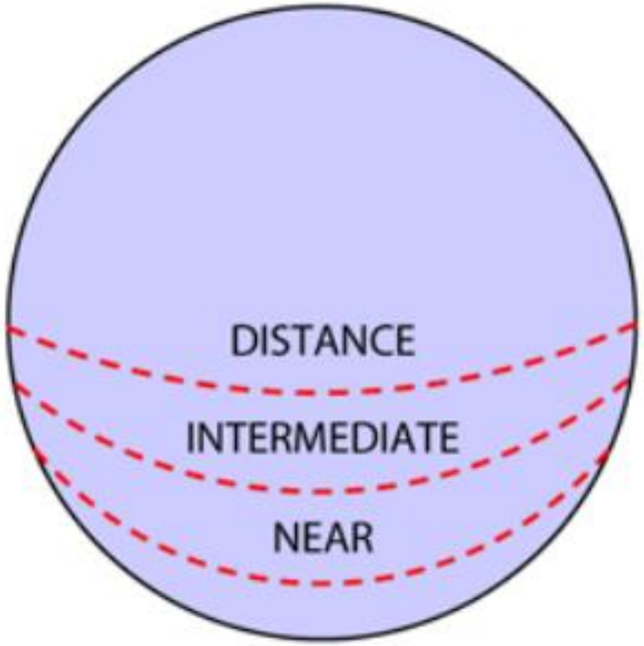
History of PAL

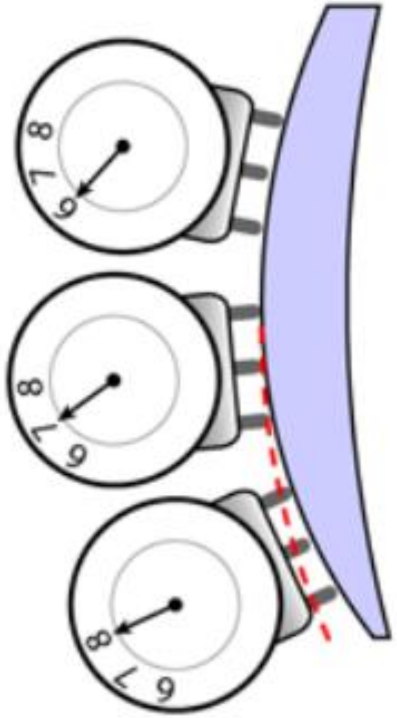
- Concept of PAL has been around since 1907
- The 1st PAL was known as omnifocal lens
- Also known as invisible bifocal no-line bifocal
- Patented by **Owen Ave**
- **Design to stimulate accommodation**

- Progressive addition lenses are one piece lenses that vary gradually in surface curvature from a minimum value in the upper distance portion to a maximum value in the lower near portion.
- Unlike bifocal or trifocal lenses, progressive lenses ensure that the presbyopic spectacle wearer finds the right dioptric power for every distance, guaranteeing smooth and uninterrupted vision without any visible line of demarcation

- The power increase is achieved by constantly decreasing the radii of curvature in the vertical and horizontal directions.







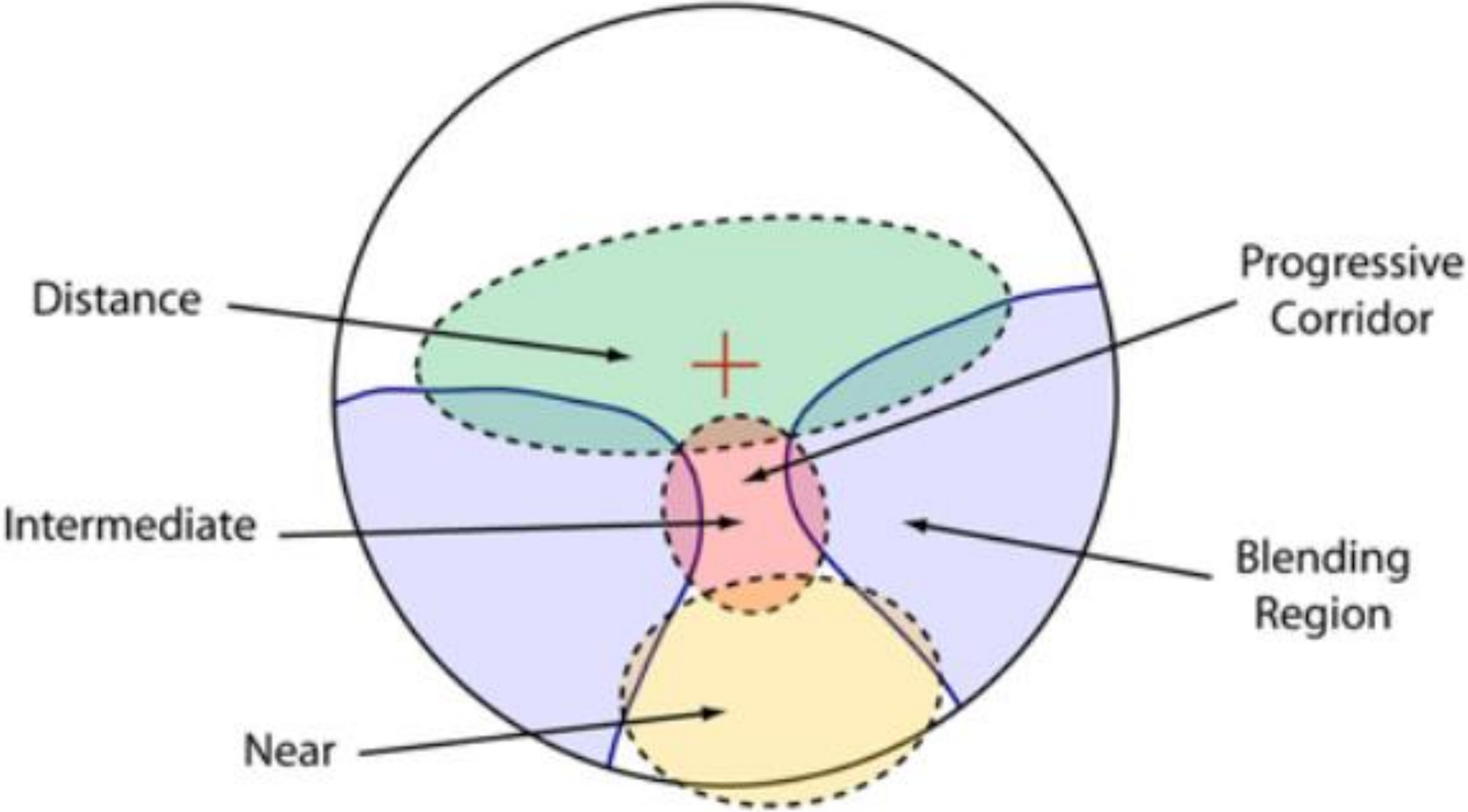
Traditional general-purpose progressive lenses possess four structural features:

Distance Zone: A stabilized region in the upper portion of the lens provides the specified distance prescription.

Near Zone: A stabilized region in the lower portion of the lens provides the specified Add power for reading.

Progressive Corridor: A corridor of increasing power connects these two zones and provides intermediate or mid-range vision.

Blending Region: The peripheral regions of the lens contain non-prescribed cylinder power and provide only minimal visual utility


Distance
Progressive
Corridor
Intermediate
Blending
Region
Near

Due to changes in curvature, there is surface astigmatism at the peripheral zone which produces an unwanted astigmatic error that can blur vision and limit wear field of clear vision. It is influenced by

Add power: Amount of astigmatism is directly proportional to add power.

Length of the progressive corridor: Shorter corridors produce higher astigmatism and larger corridor produce low level of astigmatism.

Width of distance and near zone: wider distance and near zones confine astigmatism to smaller regions of the lens.

Advantages of PAL's

Natural head position

Comfortable near and intermediate work

No image jump

Cosmetically appealing

Lighter and thinner than single vision

No visible segments

No dividing line on the lens, cosmetically better

Looks like single vision lens

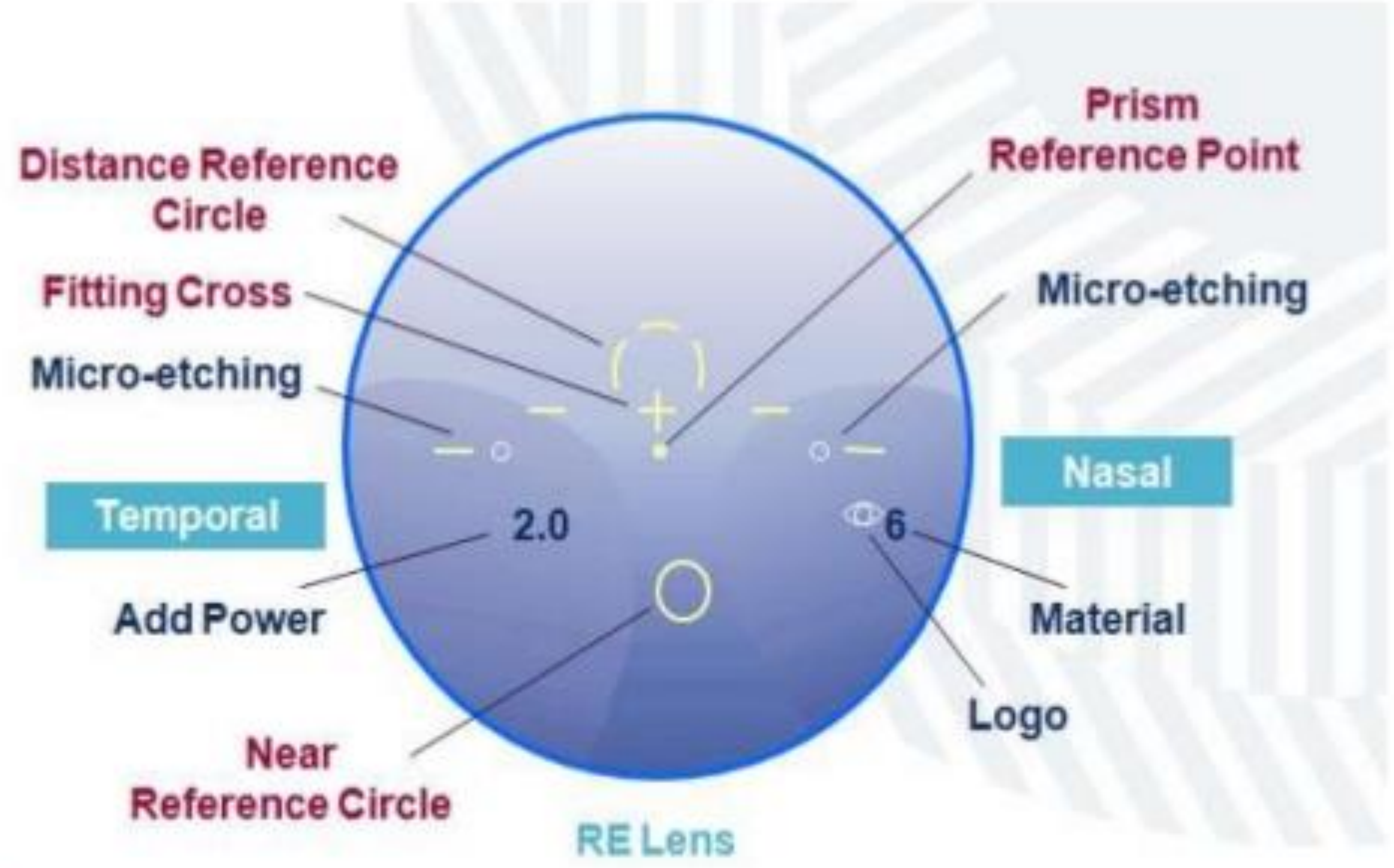
More visual comfort and natural vision

Complete range of working distances

Disadvantages of PALs

- Unwanted astigmatism at the periphery of lens which causes image swim and distortion while looking through that part of lens
- Increase in eye and head movements
- Longer adaptation time
- Expensive
- More critical fitting and more fitting steps
- Differing magnification (throughout lens)

TEMPORARY MARKINGS



Distance reference circle:

- This is the identification circle used to check the distance lens power.
- It should be crossed checked with the lensometer or focimetry.

Fitting cross:

- It should be located exactly at the centre of the patients pupil.
- It is used to measure the MPD(monocular pupillary distance) and fitting height.

Prism reference circle:

- This is the point which is used to check the amount of prism in the lens.

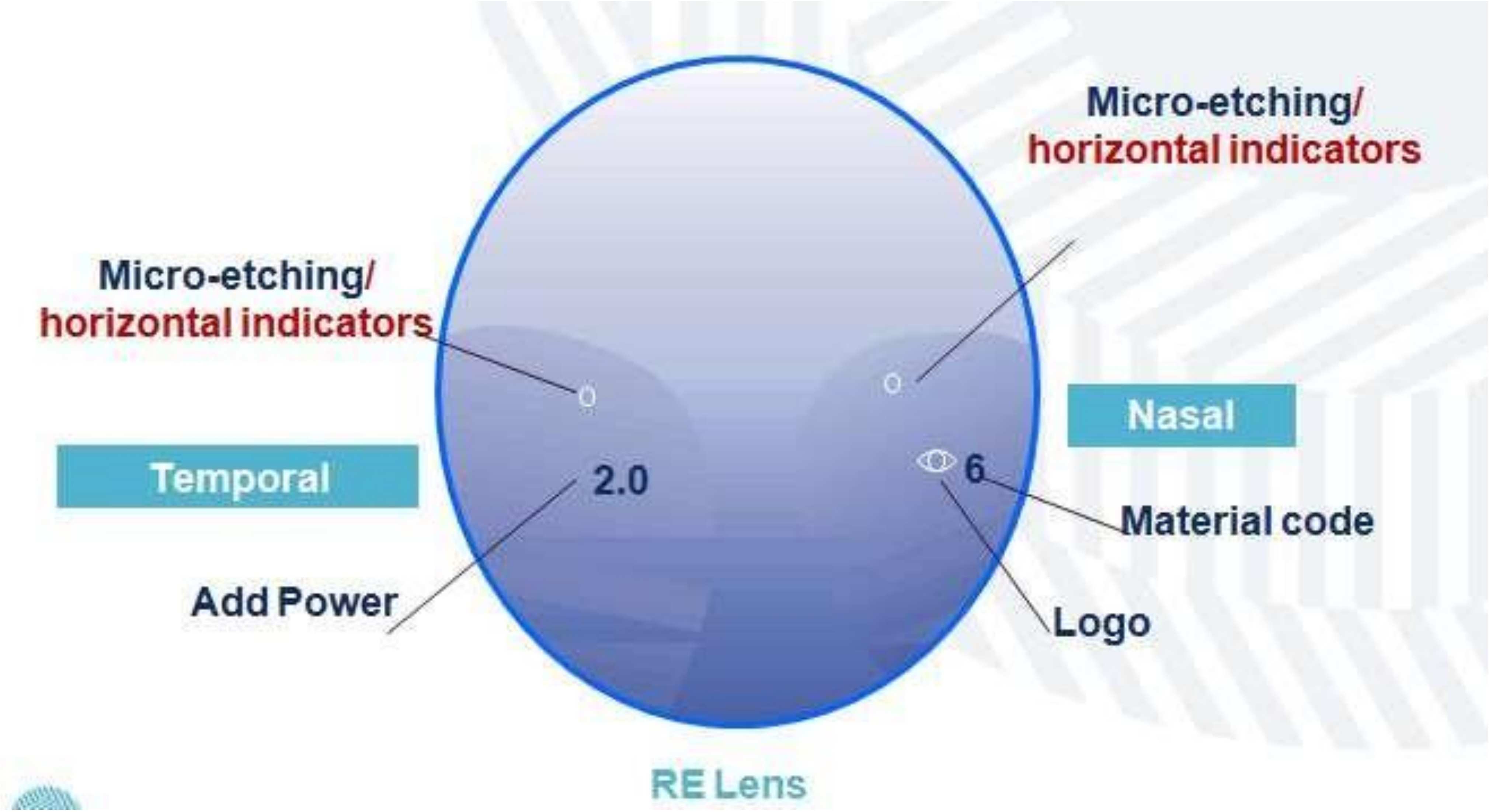
Near reference circle:

- This marking is used to check the near vision power.
- It should be verified with the lensometer.

➢ Small horizontal locater:

- This indicator should be level with the prism reference point.
- This mainly helps the surfacing lab markers to mount the lenses and check the position of horizontality.
- The horizontality precision can even be spotted easily with the naked eye.

PERMANENT MARKINGS



➢ Lateral circles:

- There are two small lateral circles that are used to relocate the temporary markings and they are positioned exactly 34 mm apart one each on the nasal and temporal sides.

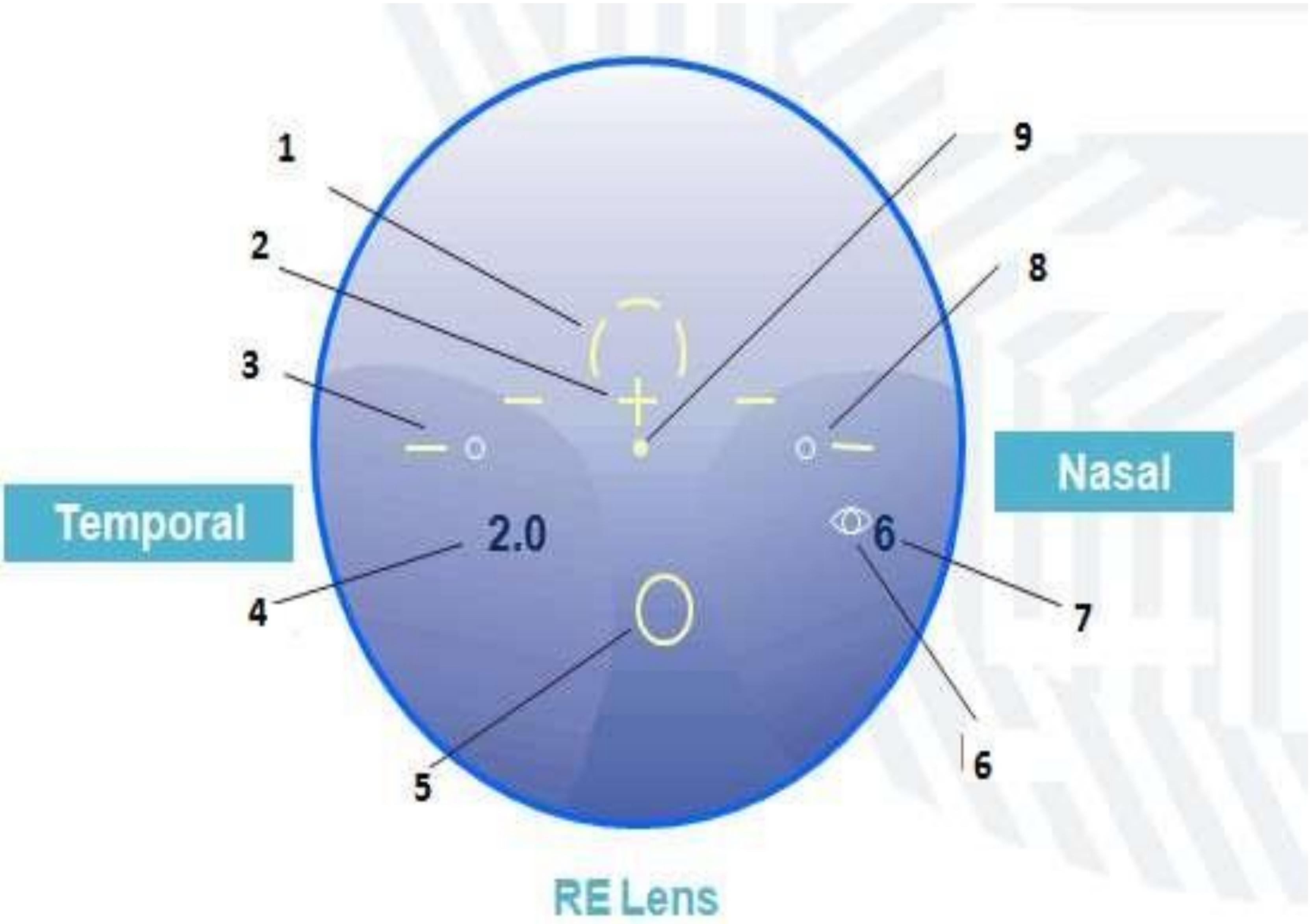
➢ Lens logo and material code:

- The lens type is identified with the help of lens logo.
- The material coat helps us to identify the type of lens material.

- E.g: In case of 1.5 index the lens logo is followed by no.6 and in case of polycarbonate lens, a letter P is seen.
- This logo is nasally located.

➢ Addition power:

- This is located below the temporal locator
- We can read the addition power directly from the lens by using the lensometer.


1
2
3
9
8
Temporal
Nasal
2.0
6
4
7
5
6
RE Lens

PROGRESSIVE ADDITION LENS DESIGNS

Hard and Soft Design

A harder progressive addition lens design concentrates the astigmatic error into smaller areas of the lens surface, thereby expanding the areas of perfectly clear vision at the expense of higher levels of blur and distortion.

- Wider distance zones
- Wider near zones
- More narrow and shorter progressive corridors
- More rapidly increasing levels of astigmatic error

A early soft progressive addition lens design spreads the astigmatic error across larger areas of the surface, thereby reducing the overall magnitude of blur at the expense of narrowing the zones of perfectly clear vision.

- Narrower distance zones
- Narrower near zones
- Longer and wider progressive corridors
- More slowly increasing levels of astigmatic error.

Hard design	Soft design
Spherical distance zone	Aspheric distance zone
Wider distance and near vision zone	Narrower distance and near vision zone
Narrow and short intermediate corridor	Wide and large intermediate corridor
Rapid increase in unwanted astigmatism	Gradual increase in unwanted astigmatism

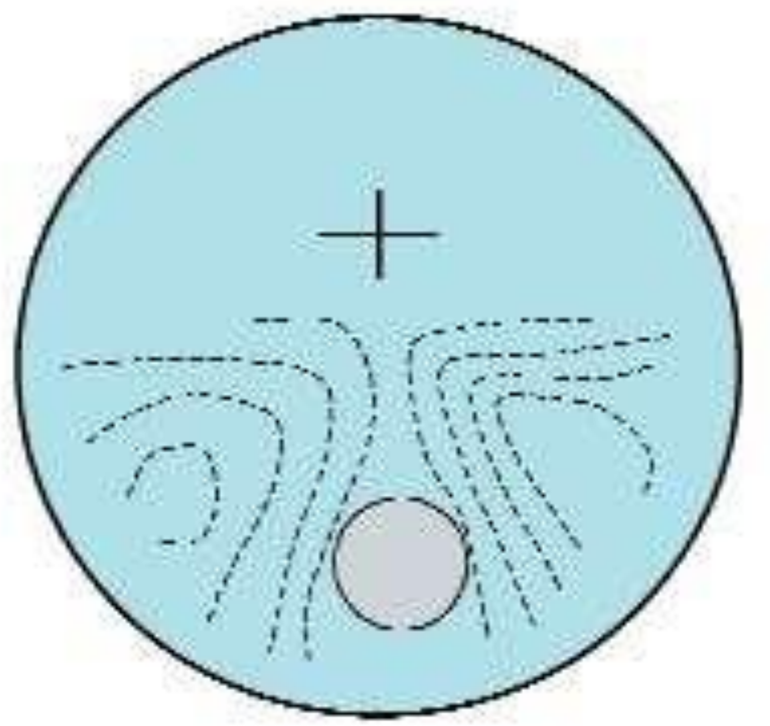
Hard design

Advantages	Disadvantages
Large distance & near area free from astigmatism	High intensity aberration at periphery
More accessible with downward rotation of eye	Distortion for longer and more difficult period of adaptation
Wider near zone even at high Rx	Swim effect

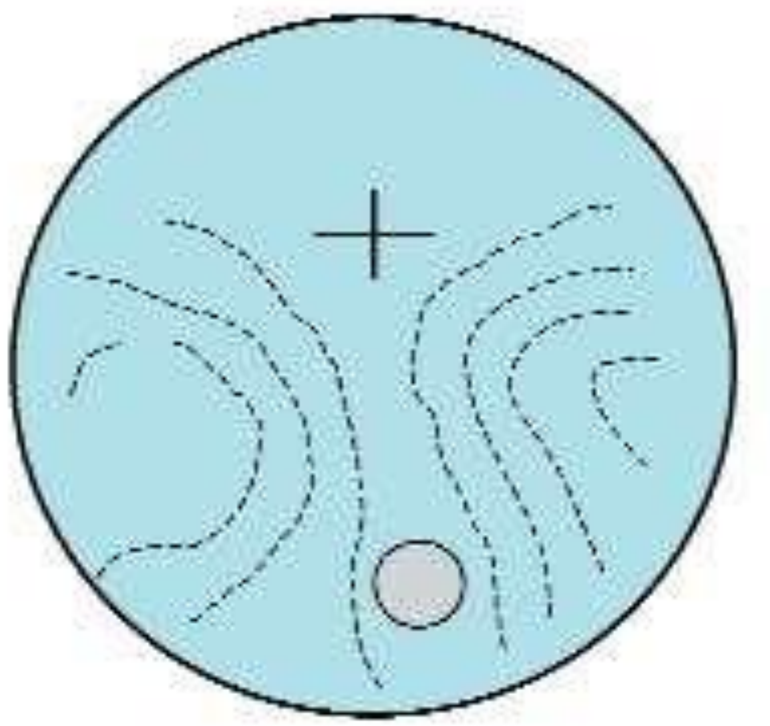
Soft design

Advantages	Disadvantages
Decreases intensity aberration at periphery	smaller field at sharp vision
Easier, more rapid adaptation	Need dropping of eye farther near to read
Less distortion of peripheral viewing	
Reduce swim effect	

Hard design



Soft design

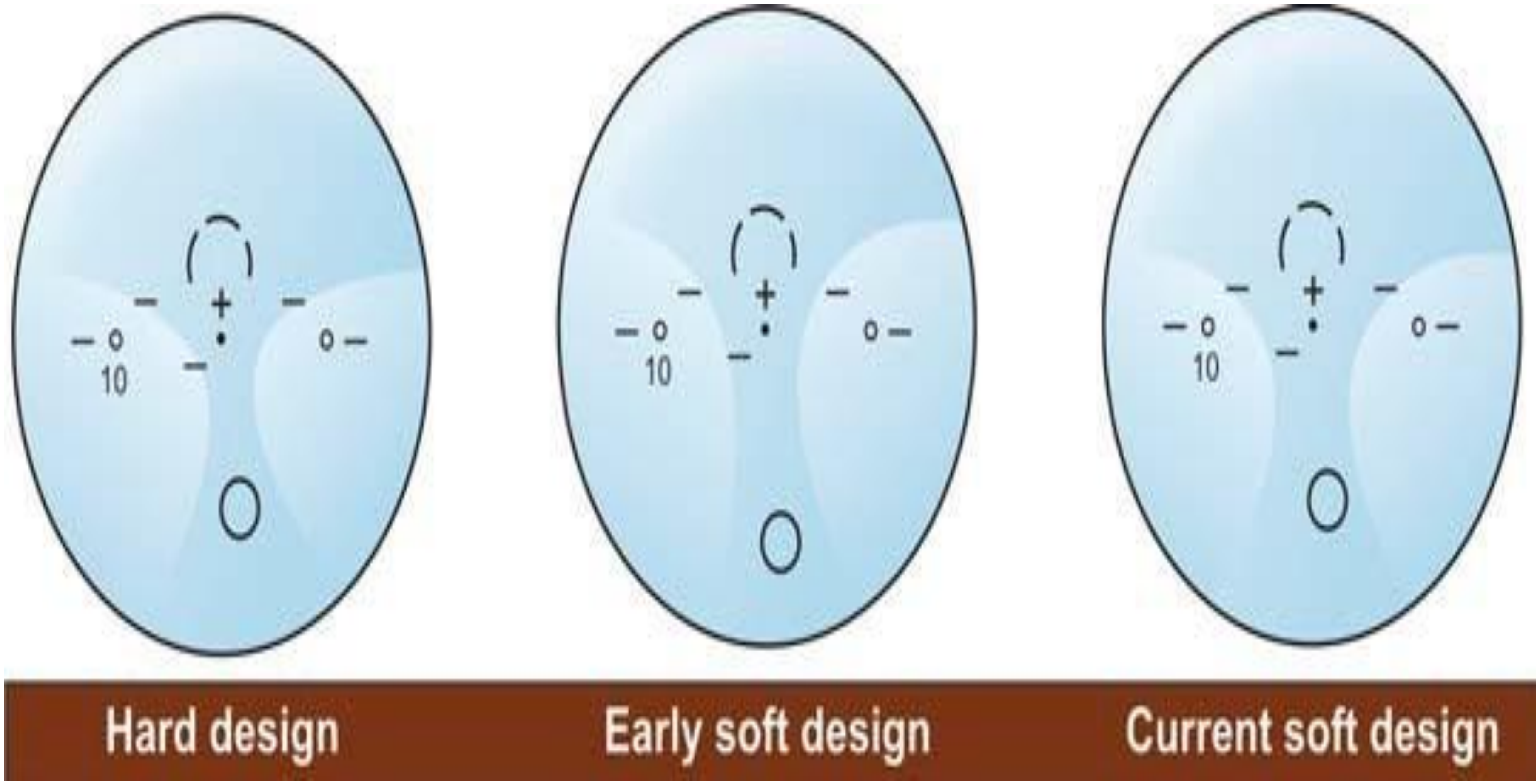


Wide distance and reading zones
Narrow intermediate zones
Close spacing of contour lines

Reduced distance and reading zone
Wider intermediate zone
Wide spacing of contour lines

Current soft design

- Combination of hard and soft design
- Larger effective distance and near zone
- Peripheral aberration are well controlled to enable the wearer to adapt easily


10
10
10
Hard design
Early soft design
Current soft design

Indication for the selection of hard and soft design

Hard design :

- Previous successful hard lens wearers
- People who do a lot of reading

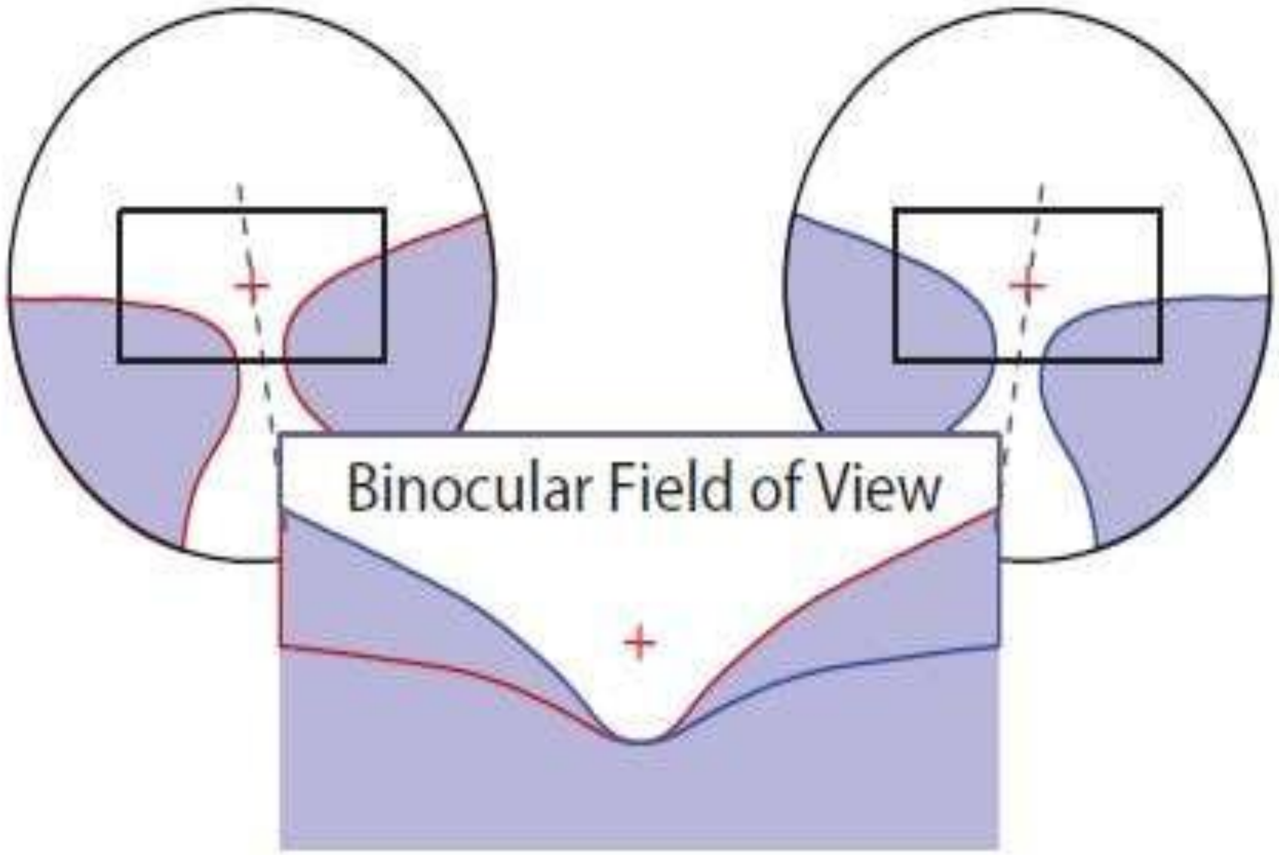
Soft design :

- Young presbyopes
- Active outdoor profession
- Professional driver

SYMMETRICAL VS ASYMMETRICAL DESIGN

Symmetrical design

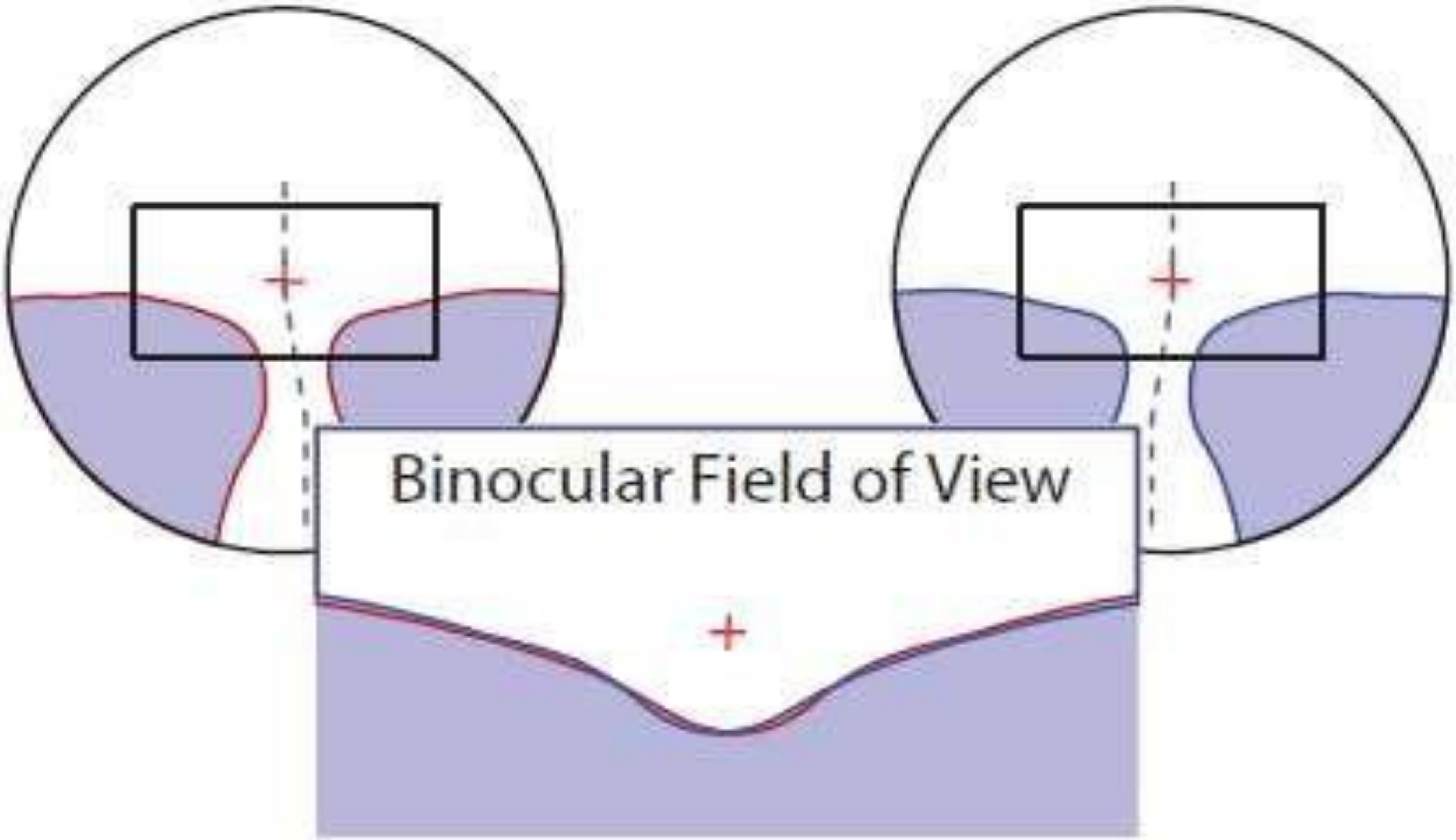
- In case of symmetrical design progressive addition lens design, the right and left lenses are identical
- Nasal decentration of near zone is achieved by lens rotation in equal and opposite amount i.e. 10 degree anti-clockwise in right and clockwise in the left lens..
- But a vertical prism imbalance is induced between two eyes which results in larger adaptation

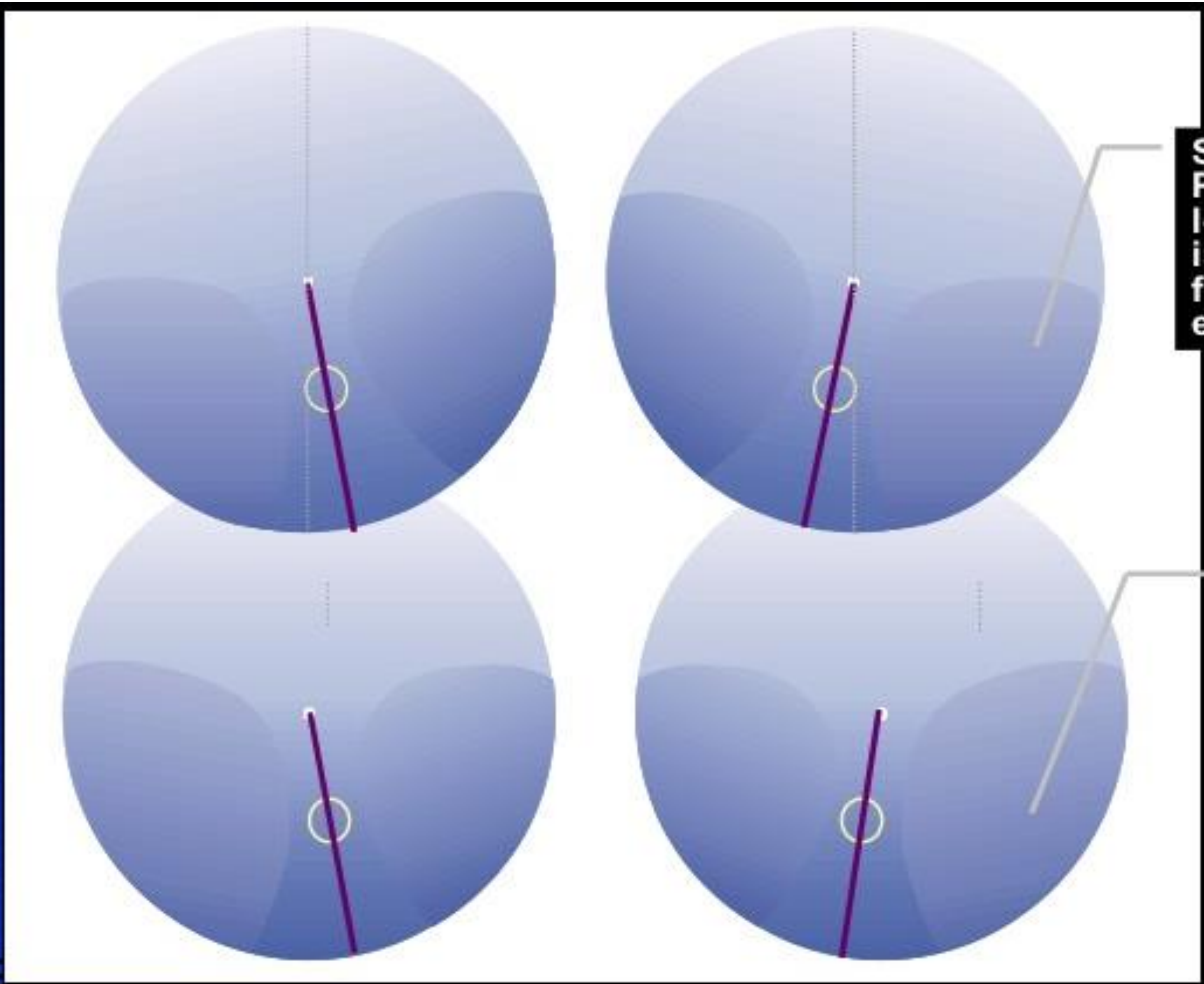

Binocular Field of View

Asymmetrical design

- Separate designs for the right and left lenses
- Amount of cylinder power on either side of progressive corridor is adjusted independently, which allows the near inset to be achieved without rotating the lens design
- The progressive corridor is initially designed at an angle with the necessary nasal ward inclination
- No need of lens rotation

- Provides better binocular alignment between the right and left viewing zones with large binocular field of view
- Incorporated a nasal offset of the near zone
- Levels of unwanted cylinder greater on nasal side of progressive corridor as a result of achieving the nasal inset without rotating the design


Binocular Field of View

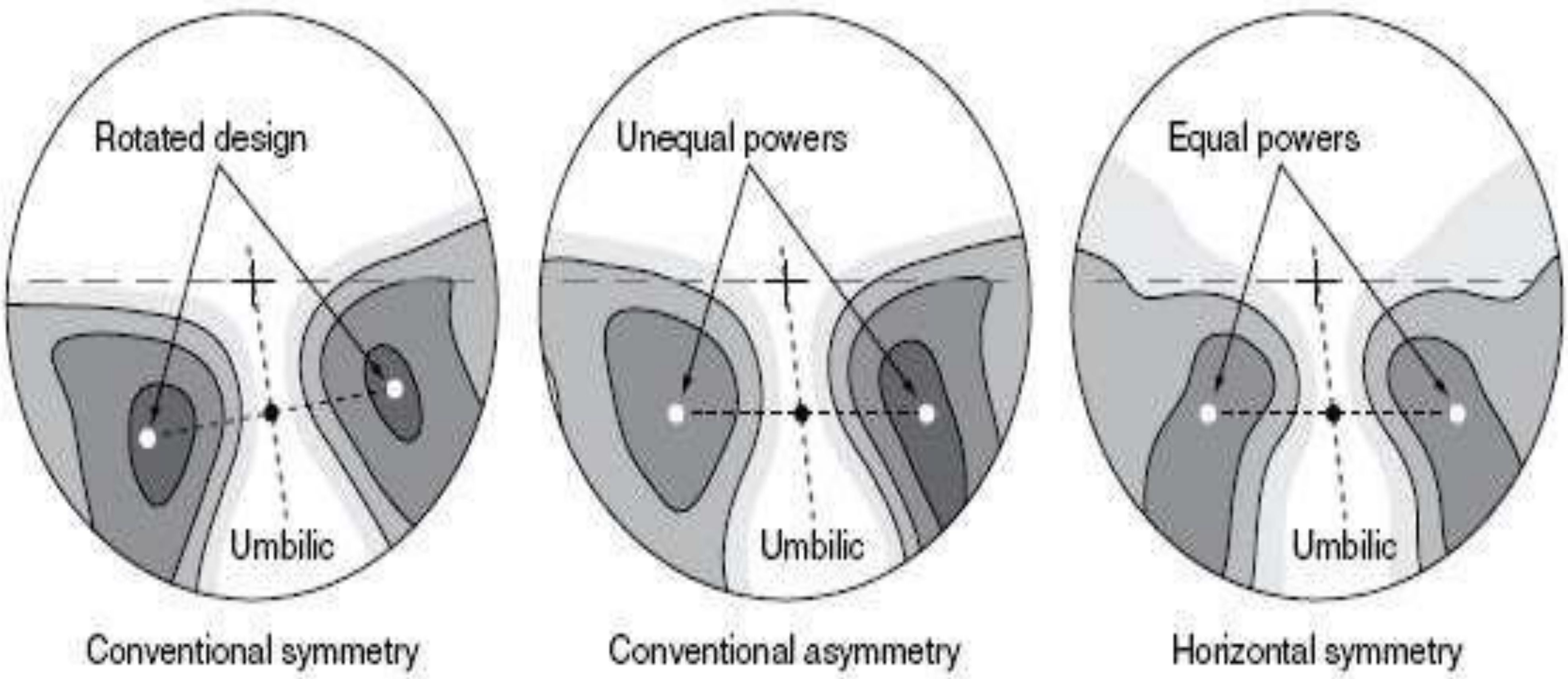


Symmetrical PAL - same lens design is rotated to fit the other eye

Asymmetrical PAL - each eye has a different lens

Horizontal symmetry

- Lenses were asymmetrical but designed to give the wearer equal acuities and prismatic effects at all corresponding points of gaze in order to achieve excellent binocular vision


Rotated design
Umbilic
Conventional symmetry
Unequal powers
Umbilic
Conventional asymmetry
Equal powers
Umbilic
Horizontal symmetry

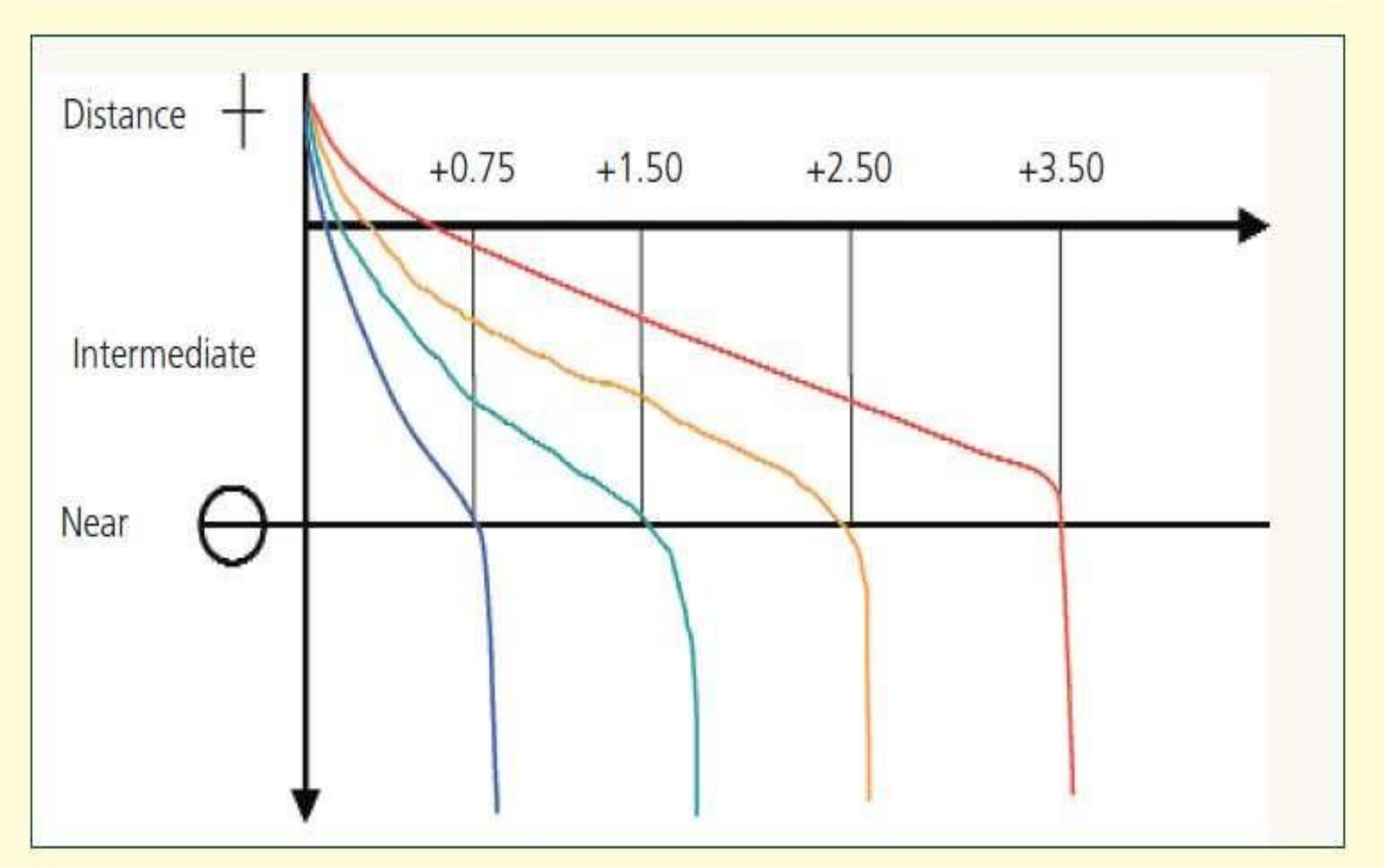
Mono design and multiple design

Mono design

- It classify hard and soft
- Maintain design principles throughout the range of addition
- It describe the characteristics of progressive zone with a range of power for a given design

Multiple design

- In 1988, Essilor introduced PAL that used a different design for each reading addition
- Incorporates the best features of hard and soft lenses
- Low reading additions were combined with a soft design which become harder as the add power is increased
- The reading area remain almost constant throughout the range
- Ensure the visual comfort and ease of adaptation at each stage of presbyopia



Progression profileof Multi design PAL

Prescription based design

- Introduced by SOLA optical
- Dedicated design for every base and add
- Design by base-different designs for hyperopes, myopes and emmetropes
- Design by add- effective near zone sizes change as the add increases
- Near inset position varies relative to level of presbyopia and reading distance
- Corridor length also varies relative to both base and add

Who is suitable for PAL

- Person having interest in trying new things
- People with small pupil
- Unsatisfied patient with bifocal
- Patient who works at shorter and middle distance
- Myopes

Contraindication

- Lots of table work
- Change in direction of gaze e.g librarian
- Lot of head and body movement e.g. sports man
- Patient wearing bifocal or trifocal and completely satisfied with their lenses
- Squint
- Anisometropia
- Nystagmus

- High cylinder
- Patient needing high add power and having larger pupil
- Who are nervous, tensed, impatient and generally intolerant of health devices
- Who are customed in wearing single vision lenses for near vision only

SPECIAL PURPOSE PALS

- Short corridor progressive lenses
- Near variable progressive lenses
- Occupational progressives that include distance powers

Short corridor progressive lenses

- Allows a PAL to be worn in a frame with a small vertical dimension
- Faster transition from the distance and near portion of lens
- Wearer is quickly into the near portion when looking downward
- Minimum fitting height should be suitable for the frame

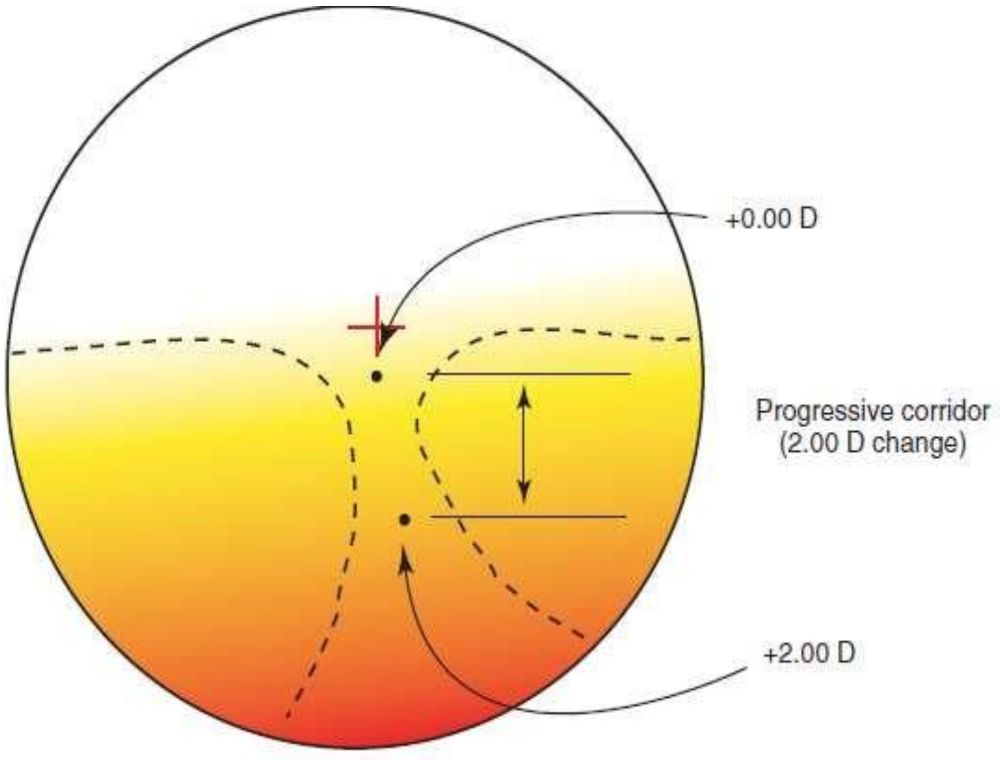
OPTOM INSIGHT

Examples of Short Corridor Progressive Lenses*

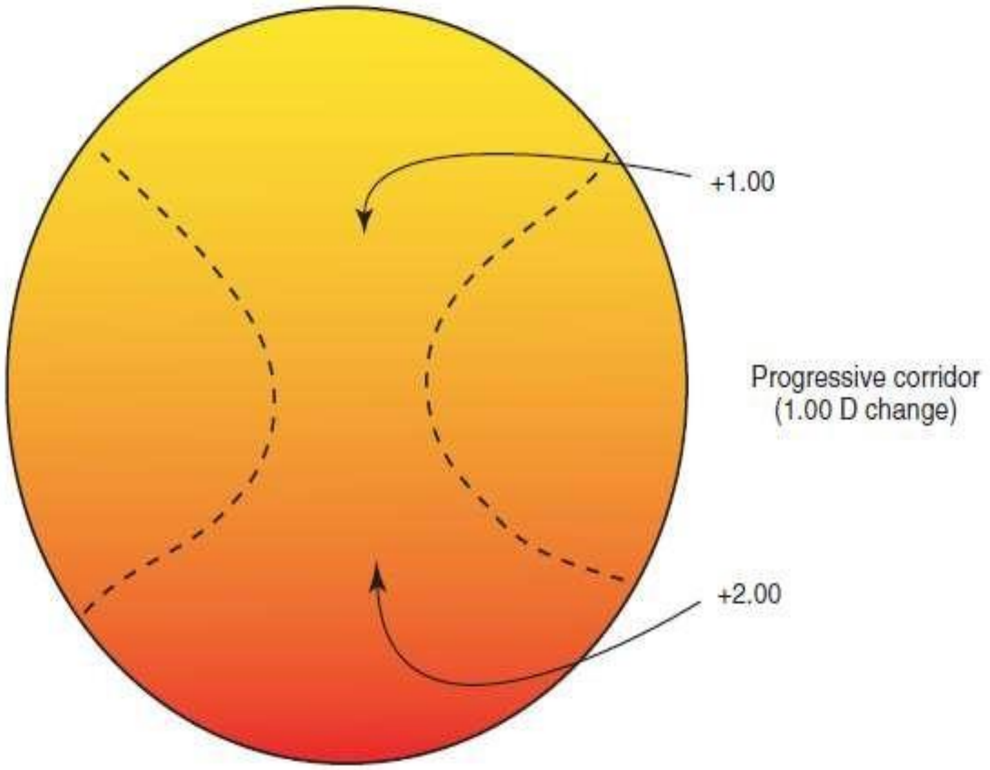
	Minimum Fitting Height
Hoya Summit CD (Compressed Design)	14 mm
Varilux Ellipse	14 mm minimum to 18 mm maximum
Shamir Piccolo	16 mm
Rodenstock Progressiv Life XS	16 mm
Zeiss's Gradal Brevity	16 mm
Kodak Concise	17 mm

Near variable progressive lenses

- Started out as a replacement for single vision reading glasses



Standard progressive



Intermediate/Near specialty progressive

OPTOM INSIGHT

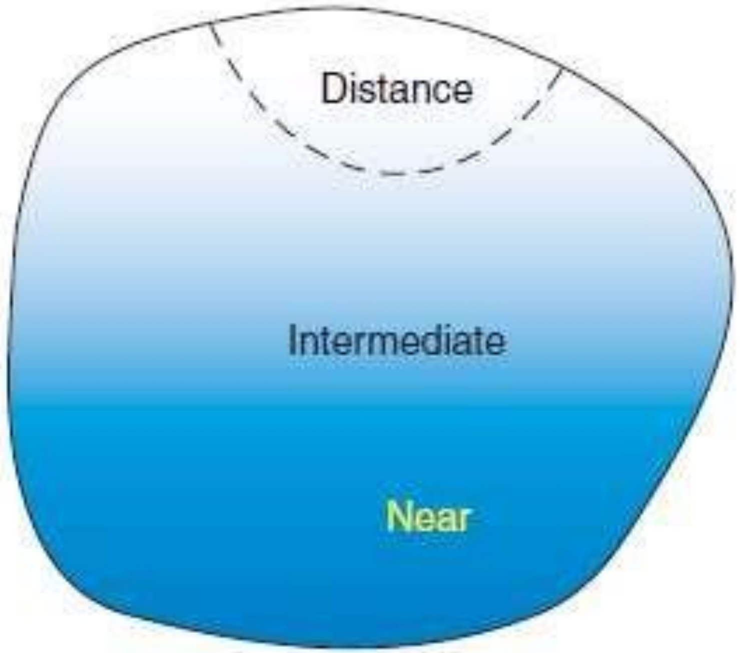
Examples of Near Variable Focus Lenses*

Near Variable Focus Lens Type	Power Ranges (Degressions)
Essilor Interview	0.80 D
Sola Continuum	1.00 D
Sola Access	0.75 D and 1.25 D
Zeiss Business	1.00 D and 1.50 D
Rodenstock Cosmolit Office	1.00 D and 1.75 D
Zeiss Gradal RD (Room Distance)	Power ranges are always 0.50 D less than the wearer's regular add power

Occupational progressives that include distance powers

- Used for small office environments and computer viewing
- Include a small distance portion located at the top of lens
- Intermediate area of the lens positioned in front of eye
- Intermediate and near zones considerably wider than standard progressives but not as wide as near variable focus lenses

- E.g. AO Technica, Hoya Tact



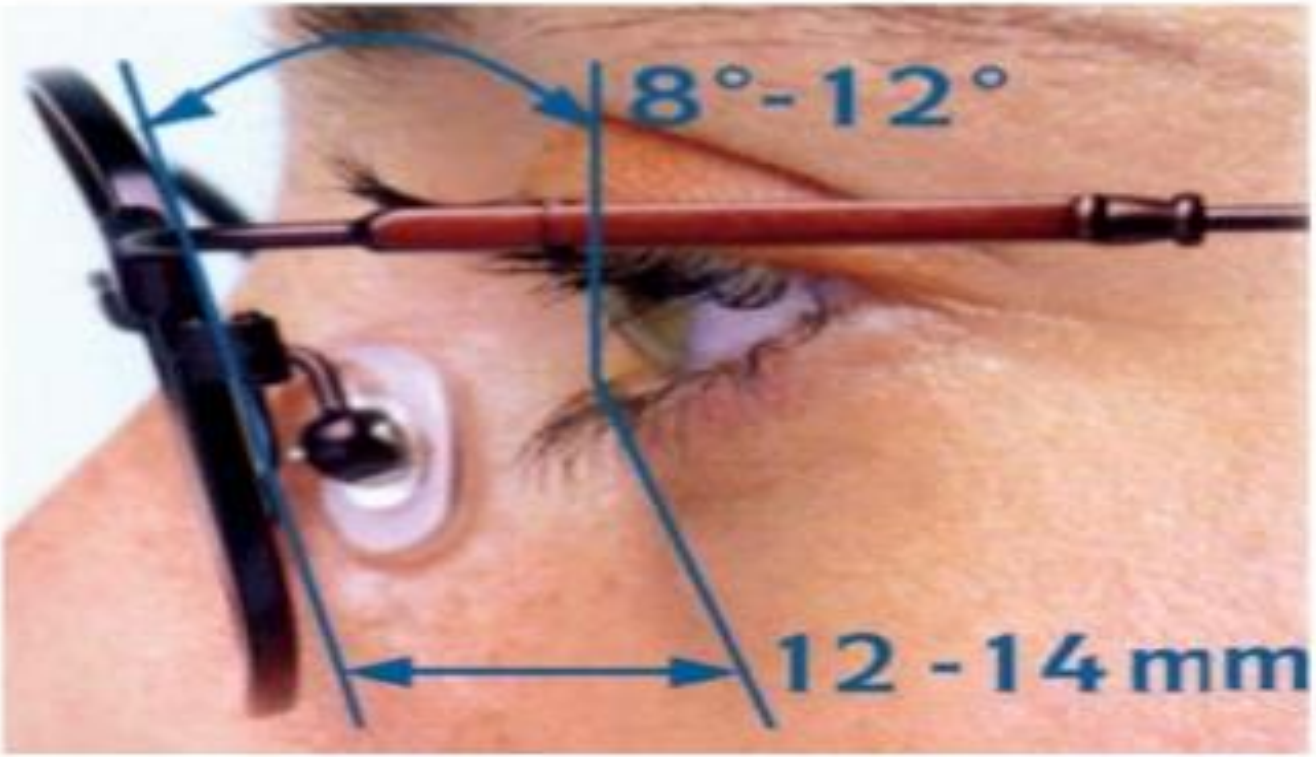
Pantoscopic angle

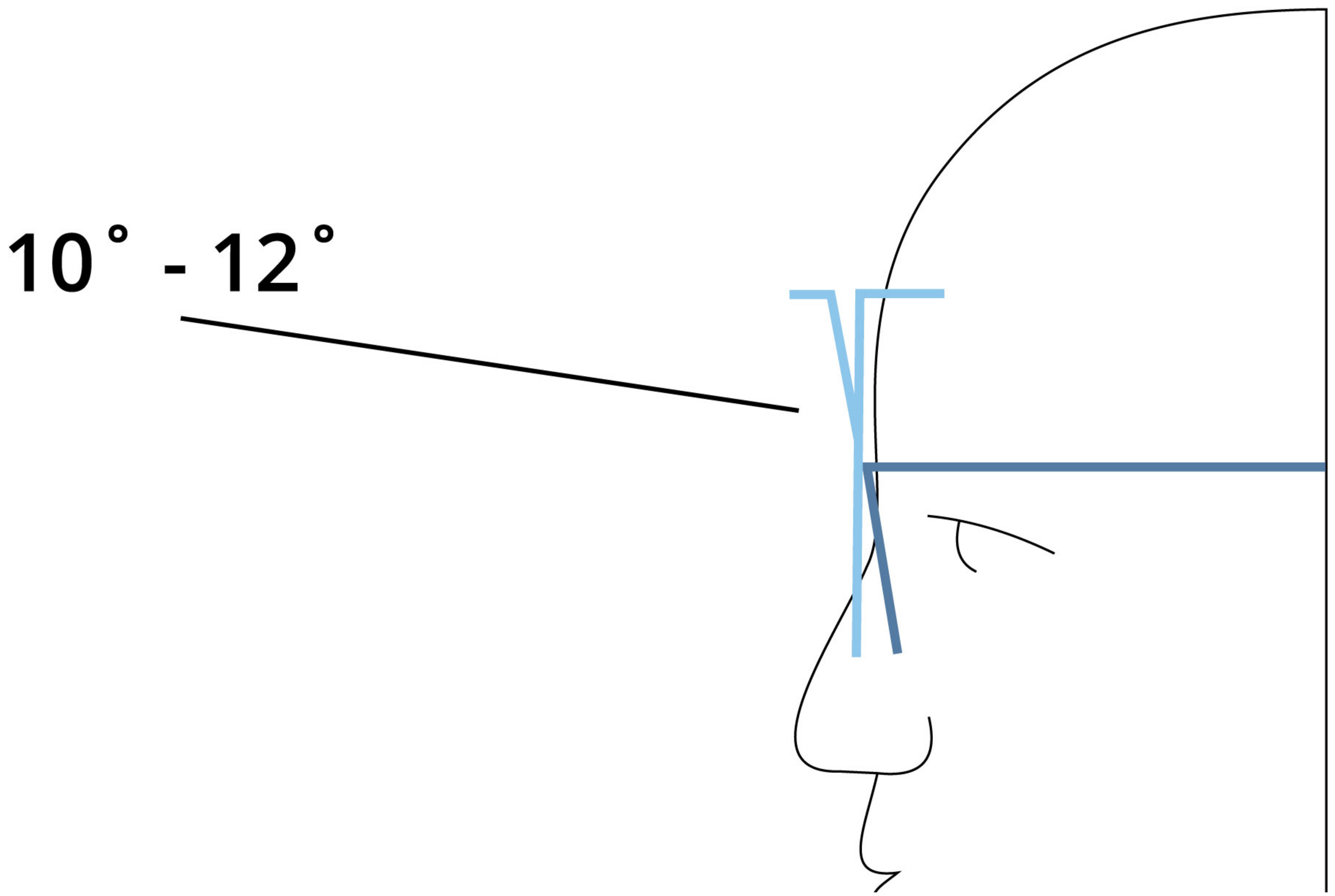
- The angle of the frame front relative to the temple. It is frame metric not an as worn metric.
- Can be adjusted by bending the temple up or down

Pantoscopic tilt

This *pantoscopic tilt* is the amount the frame front is tilted with reference to the plane of the face.

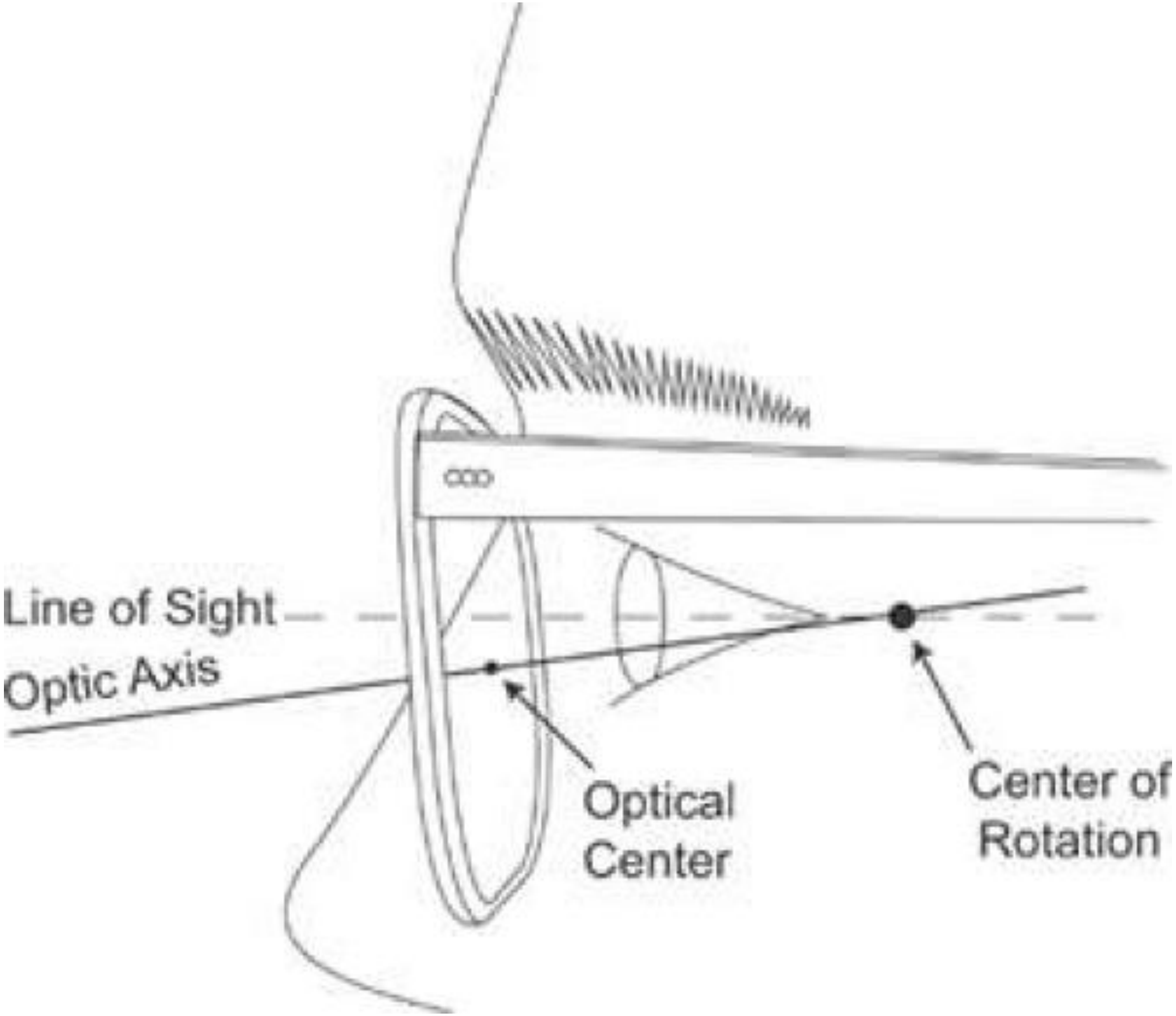
The angle formed by the lens tilt in the vertical plane relative to patient visual axis. Pantoscopic tilt is a position of wear measurement that affects how the lens is positioned in the front of the patient's visual axis




10° - 12°

Martin rule

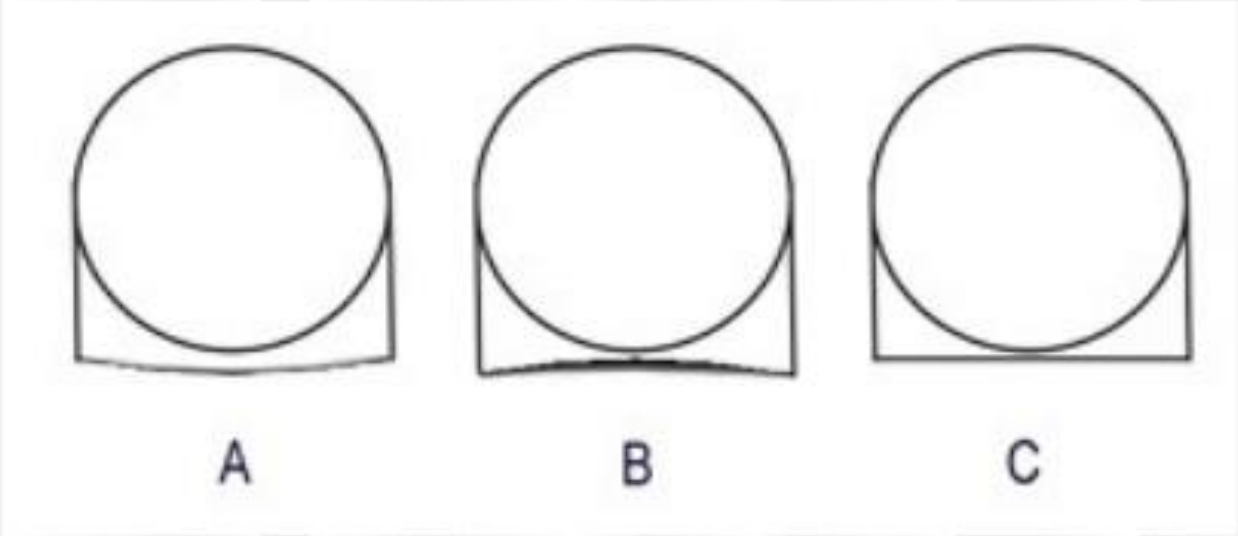
- Tilt of a lens resulting in the shifting the optical axis away from center of rotation. It means that the line of sight is at angle to the lens in the primary position of the gaze.
- For every 1 degree tilt lowering the optical center by 0.5mm
- Martin rule state that the optical center should be lower in the lens by 1mm for 2 degrees if pantoscopic tilt to compensate


Line of Sight
Optic Axis
Optical Center
Center of Rotation

Facial wrap or form

- Face form or wrap around is when the frame front is slightly rounded to form of the face
- It serves both the cosmetic purpose of improving the frame appearance and the optical purpose of aligning both surface of the lens with the wearers line of sight.

INSIGHT



New PALs designs

Atoric progressives

- Oblique astigmatism can be corrected for spherical lenses by using an aspheric surface
- But if the lens had two different powers i.e. when prescribed cylinder power is present, then oblique astigmatism could only be corrected for both meridians at once if an atoric lens design is used
- In PAL, oblique astigmatism caused by lens aberration combine with unwanted cylinder in lens periphery and degrade peripheral vision even more. If this oblique astigmatism can be reduced, peripheral vision will improve.
- E.g. Ziess Gradal Individual, Varilux Physio 360

POSITION-OF-WEAR OR AS-WORN LENS DESIGNS

- Includes following factors in the design of lens on an individual basis

- Pantoscopic tilt

- Vertex distance

- An aspheric or atoric surface

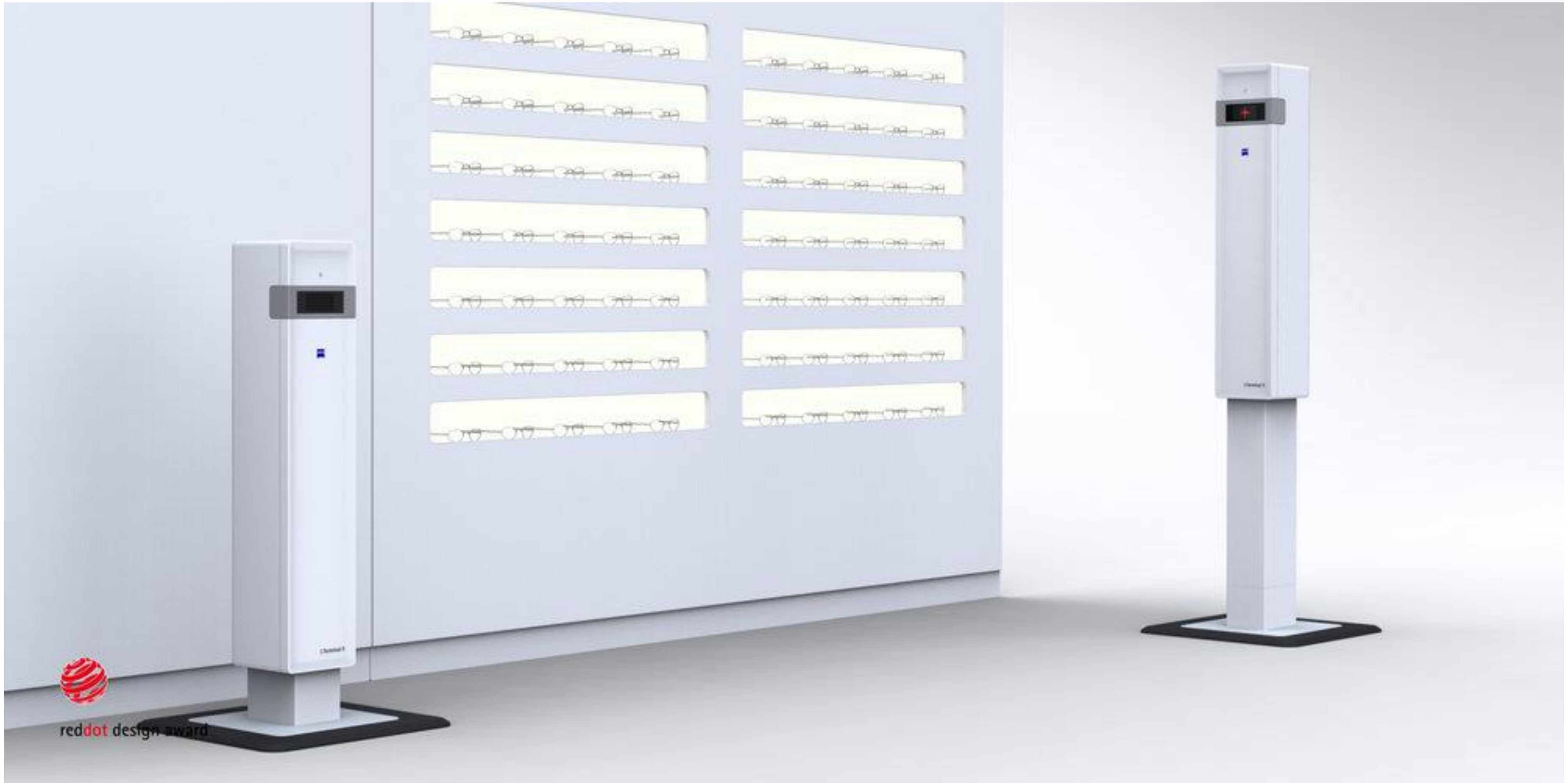
- The practitioner specify the sphere, cylinder and axis measures along

- When the prescription is received, an optimum base curve is chosen for the front surface of lens and prescription is modified to allow for tilt and vertex distance
- Then the amount of asphericity needed in each major meridian is calculated
- E.g. Rodenstock Multigressiv 2 lens

PERSONALIZED PROGRESSIVES

- Designed to match the unique head and eye movements of the wearers
- Uses an instrument called VisionPrint System to measure head and eye movement
- The lens is designed so that the near viewing area will match the personal viewing habits of the wearer
- E.g. Varilux Ipseo

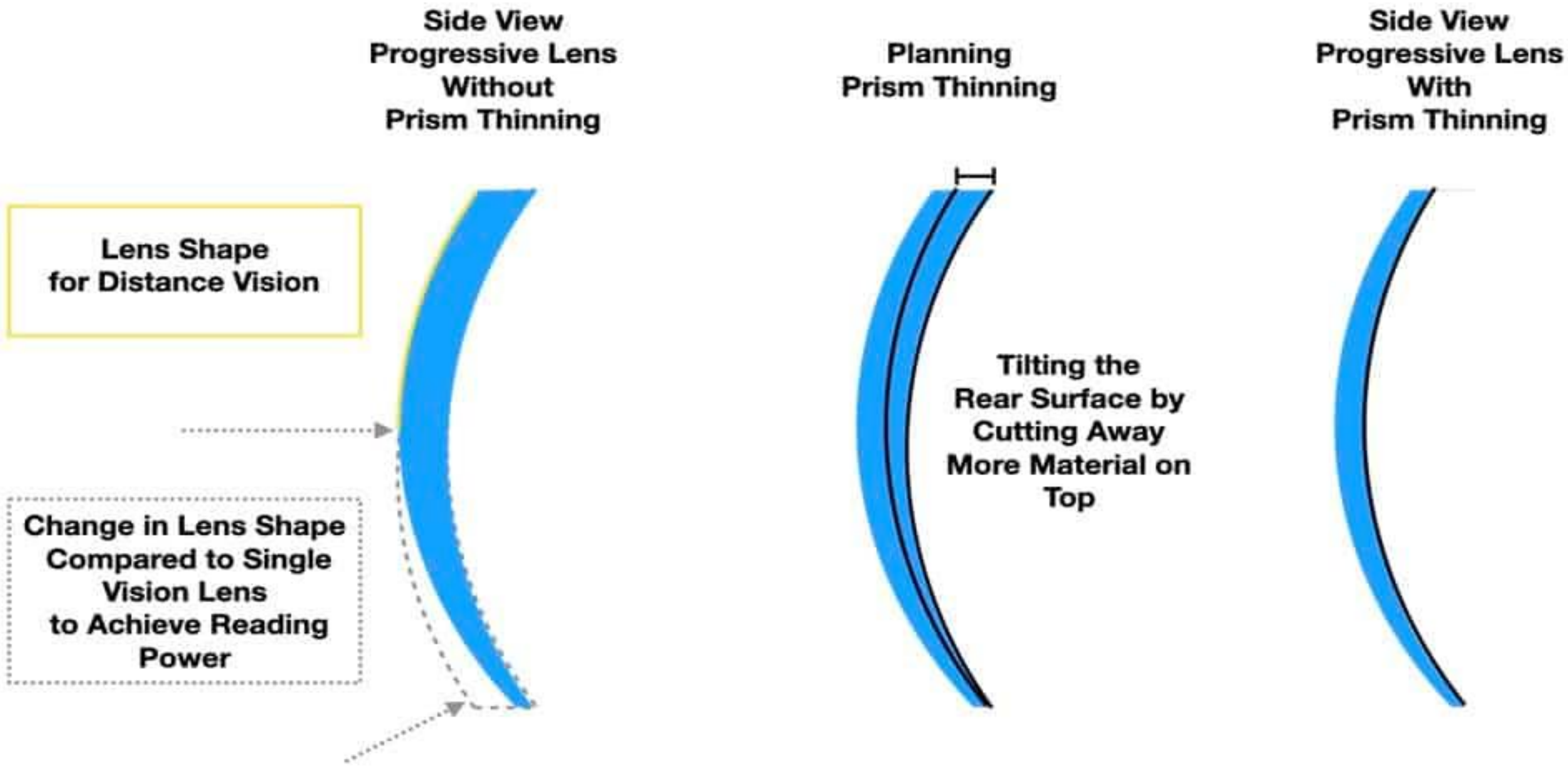

VARILUX
Varilux® Ipseo™


reddot design award

OPTOM INSIGHT

Prism thinning in PAL

To produce a thinner lens, the lens surface generally use a “equithin” technique which consist of incorporating a vertical prism in order to reduce the thickness and weight of the lens



- No prismatic effect, as the vertical prism is incorporated into the both right and left lenses
- Often referred to as “yoked prism”
- Prism thinning is a process of grinding prism into a progressive lens blank to reduce the thickness difference between the upper and lower edges
- Involves grinding base down prism
- Reduce central thickness of high lenses (add powers)

- The amount of prism needed to thin the lens varies according to the strength of addition, size and shape of lens after edging and design of the lens
- Varilux suggests adding prism power amounting to approx., 2/3rd of the power of the add. (0.66 x add)
- Tolerance- under 4 prism dioptre and 0.5 prism dioptre between the eyes.

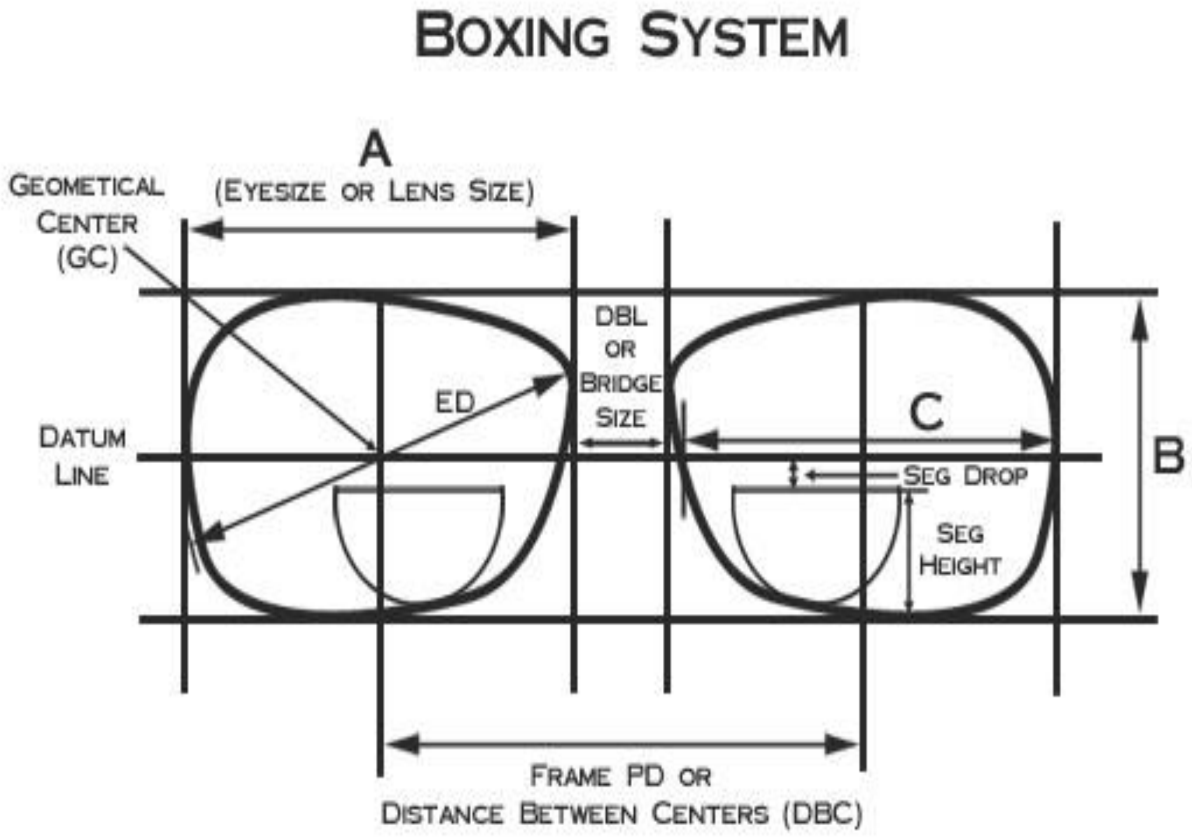
Measurement and Dispensing of Progressive Lenses

SELECTING THE FRAME

- When choosing a frame for someone wearing a progressive addition lens, there must be enough room for the progressive zone and near portion. Because these areas are not visible like a bifocal segment is, they may be unintentionally cut off.
- So frame selection is an important part of fitting progressives. Here are some important points to keep in mind:

1. The frame must have sufficient vertical depth. Each lens type has a manufacturer-recommended minimum fitting height. Standard minimum progressive addition lens fitting heights will vary, going down to a low of about 18 mm. If there is not enough vertical depth to allow the minimum fitting height, then either a different frame must be chosen, or a special short corridor lens that is designed for frames with a narrow vertical dimension should be used.

2. The frame must have sufficient lens area in the lower nasal portion where the near progressive optics are found. Sometime the frame has a large enough "B" dimension, but the shape is cut away nasally. Aviator shapes are an example of this type of frame.



3. The frame should have a short vertex distance. The closer the frame is to the eyes, the wider the field of view will be for both reading and distance vision.

4. The frame must be able to be adjusted for pantoscopic angle when facial structure will allow. A 10- to 12-degree angle is recommended. The intermediate and near fields of view are effectively wider when the progressive and near zones are closer to the eyes.

5. The frame must have sufficient face form. This also allows a wider viewing area through the progressive corridor.

CHOOSING THE RIGHT TYPE OF PROGRESSIVE

- What type of general purpose progressive is appropriate? It is possible to choose a certain type of general purpose progressive to fit the needs of the Wearer.
- Does the wearer have a significant amount of cylinder power in the prescription? If so consider using a lens design that is Atoric.
- If the vertical "B" dimension of the frame is small, choose a short corridor progressive lens. A short corridor lens is still used for general purposes, but is meant for this type of frame.
- Does this person use a computer a lot? Do they work in a small office environment where intermediate vision is important? If so they may need a near variable focus occupational progressive lens

Fitting of PAL

- It require adequate training and skills
- It involves communication and counselling skills and convincing power

Consideration

- Power of distance correction
- Pupil size
- Previous experience with multifocal
- Habitual head and eye movement
- Height of commonly viewed objects
- Frequency of use of near and intermediate vision range

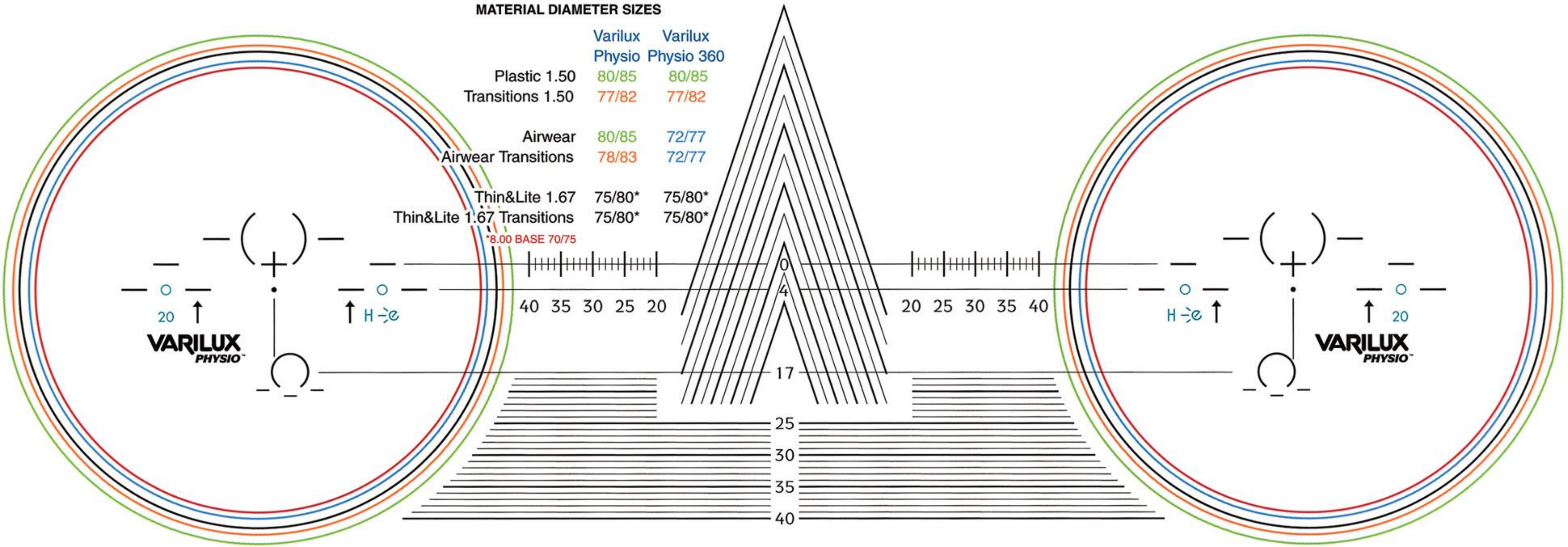
Standard Method for Taking Progressive Lens Fitting Measurements

The following measurement techniques are applicable to all manufacturers or designs of progressive lenses, provided the centration chart of the specific manufacturer is used for the lenses being measured.

MATERIAL DIAMETER SIZES

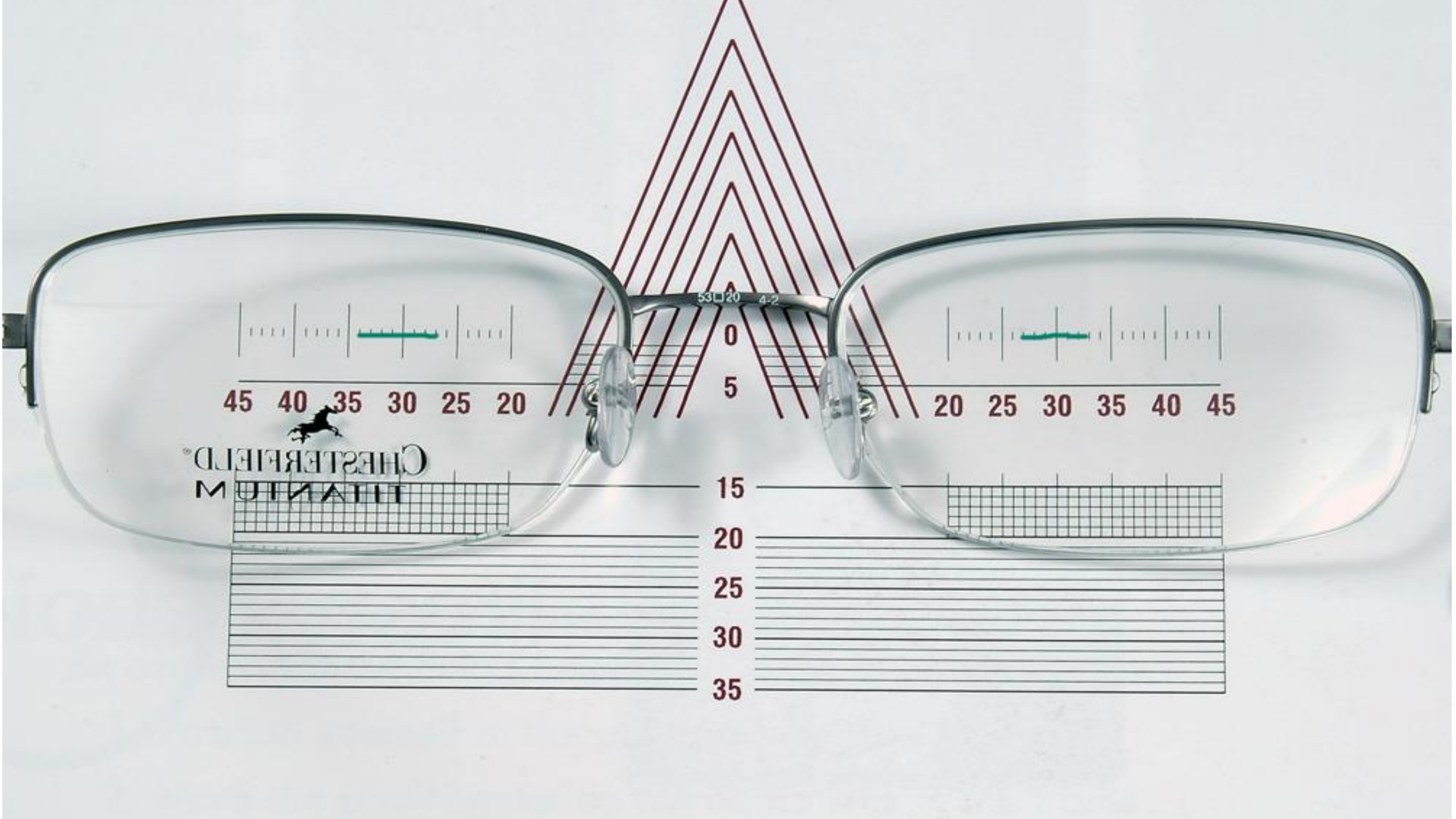
	Varilux Physio	Varilux Physio 360
Plastic 1.50	80/85	80/85
Transitions 1.50	77/82	77/82
Airwear	80/85	72/77
Airwear Transitions	78/83	72/77
Thin&Lite 1.67	75/80*	75/80*
Thin&Lite 1.67 Transitions	75/80*	75/80*

*8.00 BASE 70/75



1. Measure monocular distance PDs. The recommended method is to use a pupillometer.
2. Fit and fully adjust the actual frame to be worn. This includes pantoscopic tilt, frame height, vertex distance, face form, and nosepad alignment. Make certain the frame is straight on the face. If the temples are not adjusted, hold the frame in place while measuring so that it will not slip down the nose.
3. If the frame does not contain clear plastic lenses or the wearer’s old lenses, place clear (nonfrosted), transparent tape across the eyewire of the empty frame.

4. The dispenser is positioned with his or her eyes at the wearer’s eye level. With the wearer looking at the bridge of the fitter’s nose, the dispenser draws a horizontal line on the lens or tape. The line should go through the center of the pupil. This is done for both right and left eyes.
5. Place the frame on the manufacturer’s centration chart and move it left or right until the bridge is centered on the diagonally converging central alignment pattern. Then move the frame up or down until the marked horizontal pupil center lines are on the chart’s horizontal axis. Mark the previously measured PD for each eye as a vertical line that crosses the horizontal one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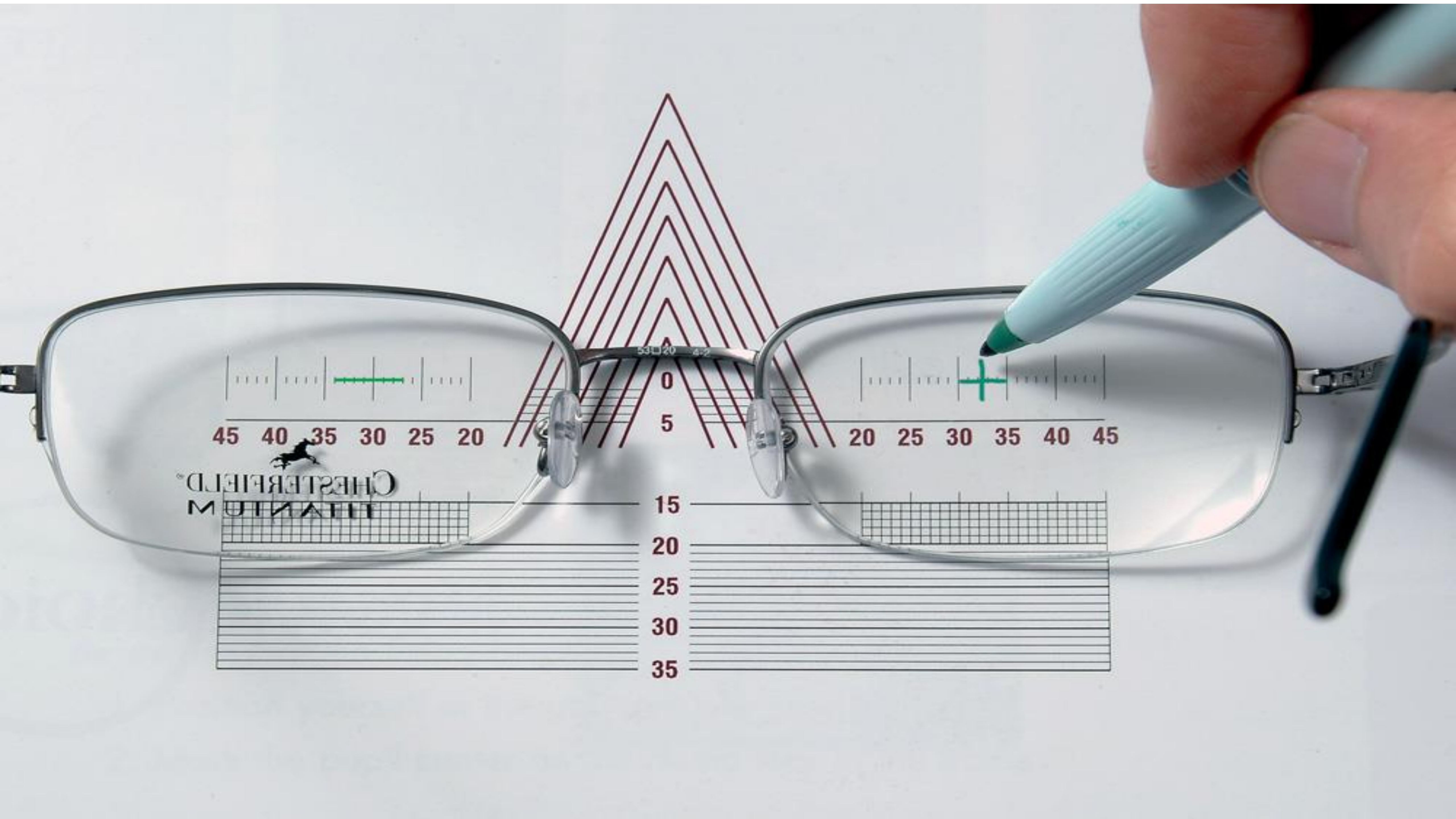
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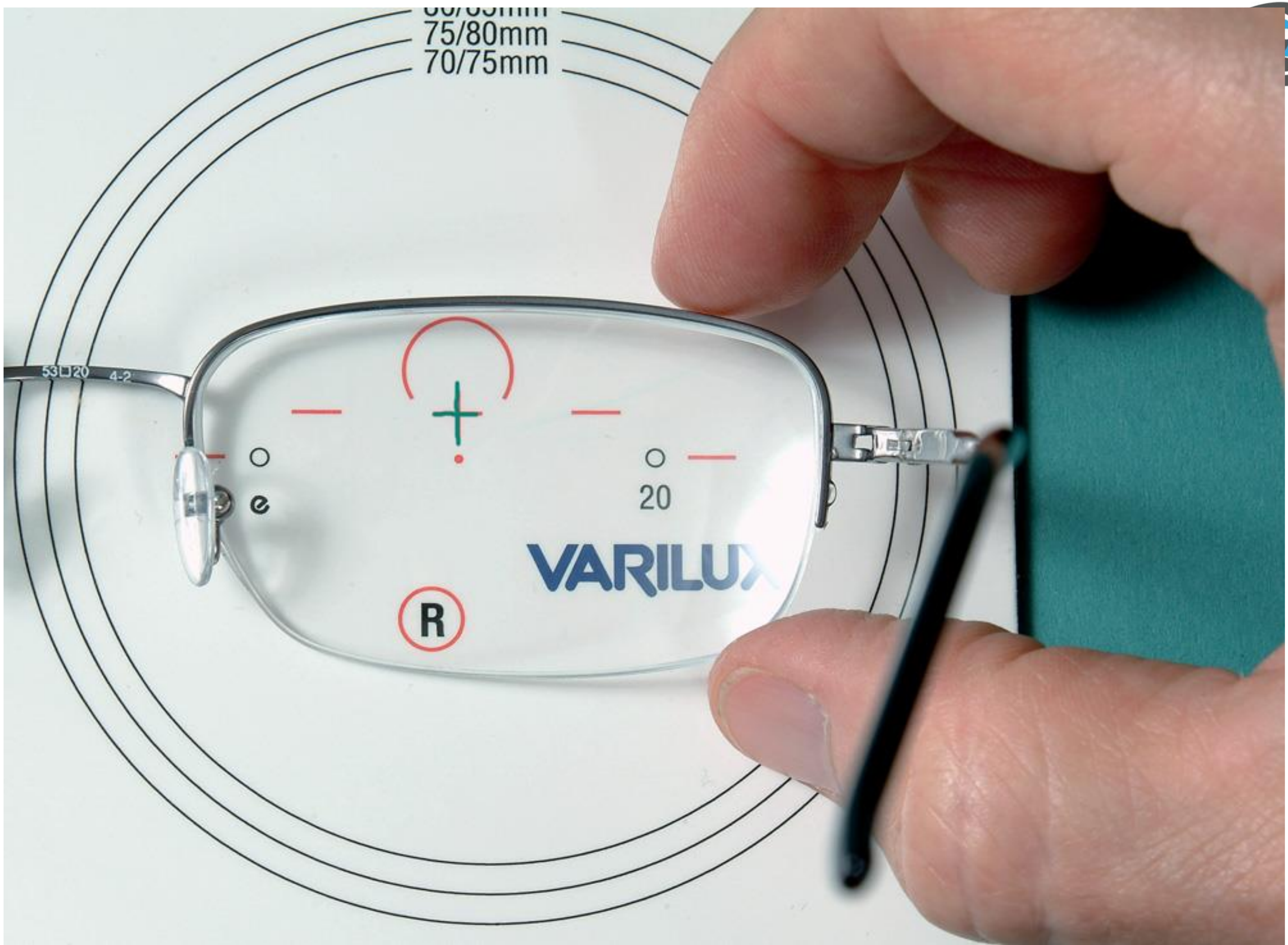
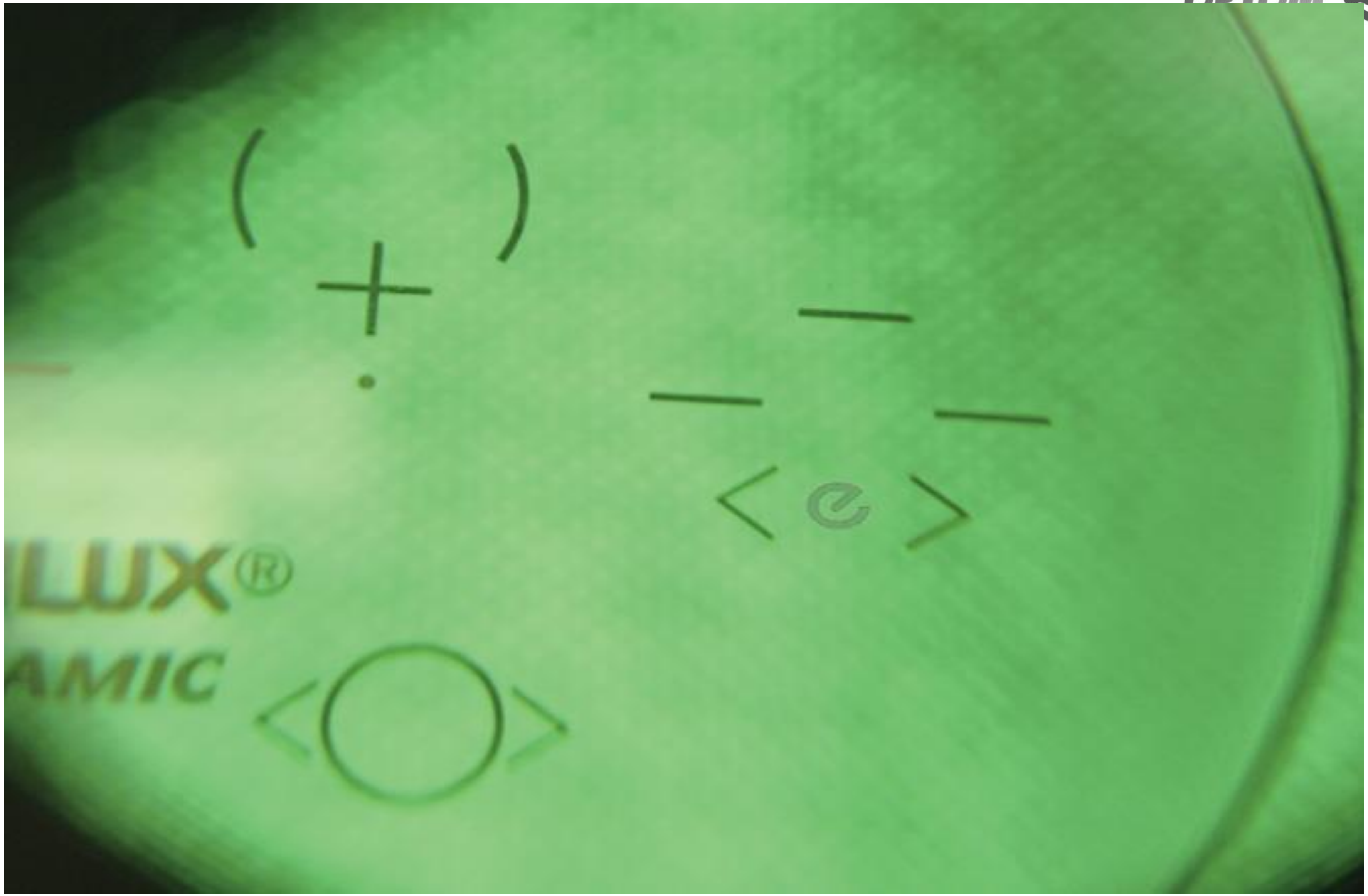
6. For first one lens, then the other, read the fitting cross heights from the chart. (Fitting cross height is the vertical distance from the fitting cross to the level of the inside bevel of the lower eyewire of the frame.) Record these fitting cross heights and the monocular PDs on the order form and in the wearer's record.
7. Check the size and shape of the frame on the lens picture portion of the centration chart. Do this by placing the frame on the lens blank circles of the centration chart so that the cross on the glazed lens overlaps the fitting cross on the picture. The circle should completely enclose the frame's lens shape.
8. Send the frame to the laboratory with the marks still on the lenses or tape.



INSIGHT

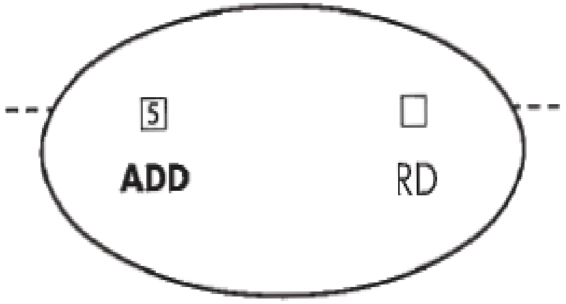
Identifying an Unknown Progressive Lens

Association's (OLA) Progressive Identifier


LUX®
AMIC

Gradal RD

Carl Zeiss Vision C



Materials:
Plastic (CR39 and 1.50)

Standard Progressive

Fitting cross location: 6mm above 180 line
Rec. minimum fitting height: 21mm

Available as: Clear
Available in: US and Canada

PAL Design on Front Side

GT2

Carl Zeiss Vision D

M	Materials:
60	Glass High Index (>1.60)
80	Glass Ultra High Index (>1.70)
50	Plastic (CR39 and 1.50)
59	Polycarbonate
67	Plastic Ultra High Index (>1.67)
60	Plastic High Index (1.60)(Canada only)

Standard Progressive

Fitting cross location: 4mm above 180 line
Rec. minimum fitting height: 17mm

Available as: Clear; Photochromic; Polarized
Available in: US and Canada

PAL Design on Front Side

Compensating Fitting Cross Height or Monocular PDs for Prescribed Prism

How to Compensate Fitting Cross Height for Prescribed Vertical Prism

1. Measure the fitting cross heights.

2. Multiply the amount(s) of prescribed vertical prism by 0.3.

3. If the prism is base down, raise the fitting cross height by the calculated amount. If the prism is base up, lower the fitting cross height by the calculated amount.

How to Compensate Monocular PDs for Prescribed Horizontal Prism

1. Measure monocular PDs using a pupillometer.
2. Multiply the amount(s) of prescribed horizontal prism by 0.3.
3. Modify the monocular PD(s) by the calculated amount, increasing the PD for base in prism and decreasing the PD for base out prism.

A prescription reads as follows:

R: +2.75 −1.00 × 180 3Δ base up

L: +2.75 −1.00 × 180 3Δ base down

The frame of choice is adjusted to fit as it should when being worn. Next fitting cross heights are marked on the glazed lenses to correspond to pupil center location. Heights are measured to be as follows:

R: 27 mm

L: 27 mm

What fitting cross heights should be ordered?

Vertical prism amount x 0.3 = change in fitting cross height in millimetres.

Or in this case 3x 0.3 = 0.9 mm

This is rounded off to 1 mm.

R: 26 mm

L: 28 mm