Impact of high power and high incidence angles on peripheral prism for homonymous hemianopia

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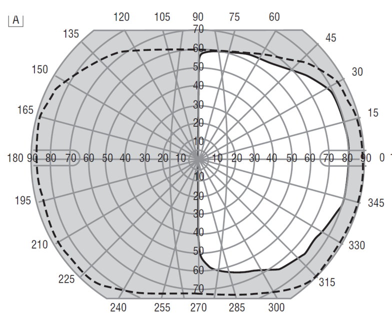
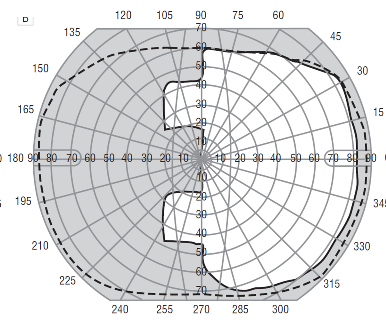
Introduction

- **Homonymous Hemianopia** (HH) occurs due to stroke, head injury or brain surgery
- **Peripheral Prisms**[1,2] (2000)
  Expand upper and lower segments of the lateral visual field using Fresnel prisms

Peli Prism glasses
Rigid Fresnel Peripheral Prisms

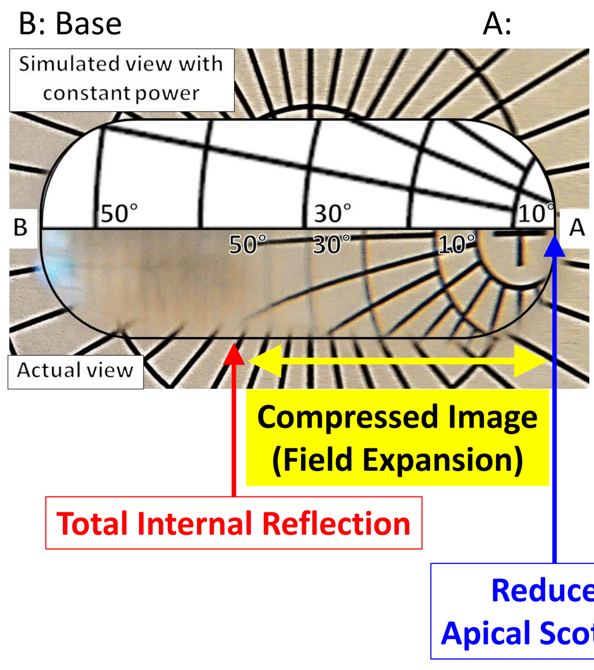


Binocular visual field of a person with HH



Binocular visual field expansion with 40Δ peripheral prisms

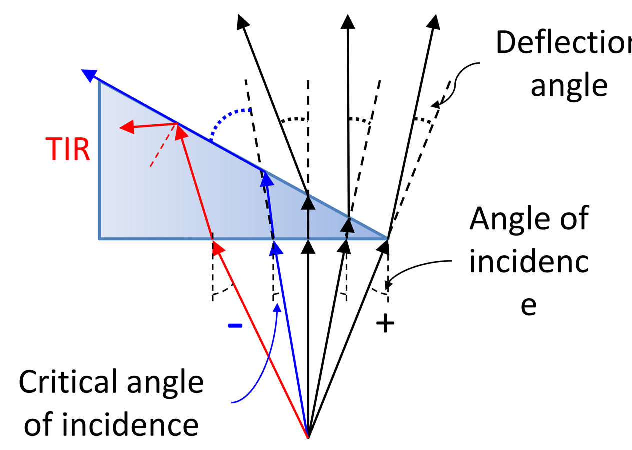
Distortion and Reflections in High Power (57Δ) Fresnel Prism

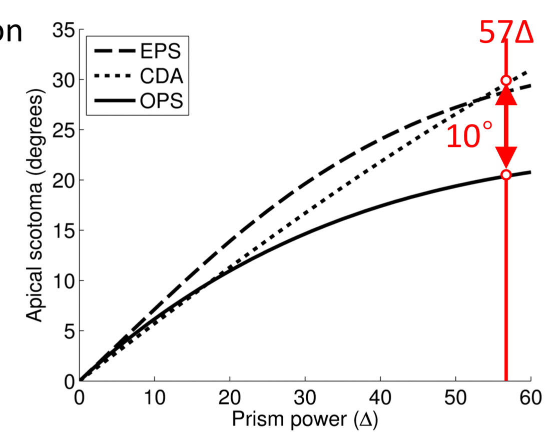


- **Prism distortion**[3,4]
  Prism power variation results in **reduced apical scotoma** and **minification** (increased field expansion)
- **Spurious reflections**
  Dimly show unrelated regions of the scene (grid lines and blue blur from a window).
  – **Total Internal Reflection (TIR)**
  Beyond the red arrow, only reflection portions (grid lines) are seen.

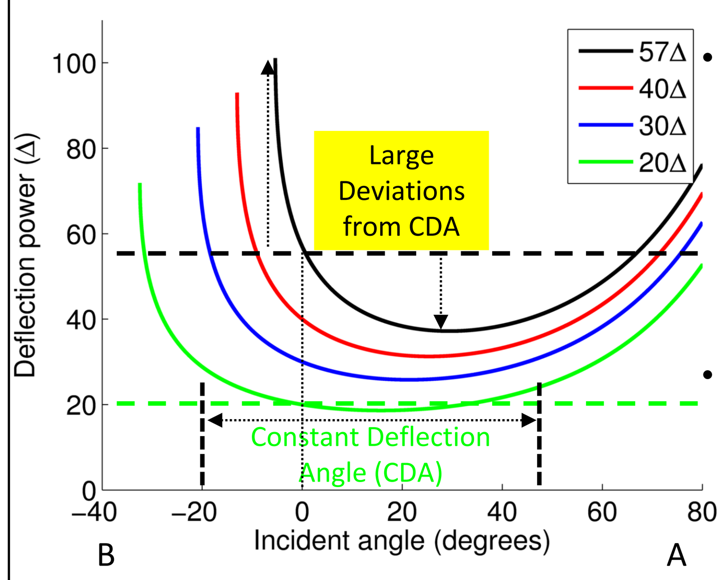
Prism Power Variation by Angle of Incidence

- Deflection angle is highly dependent on the **angle of incidence**
- Above a critical angle of incidence, **total internal reflection (TIR)**
- The size of **Apical scotoma** is same as the effective prism power **at the apex**.





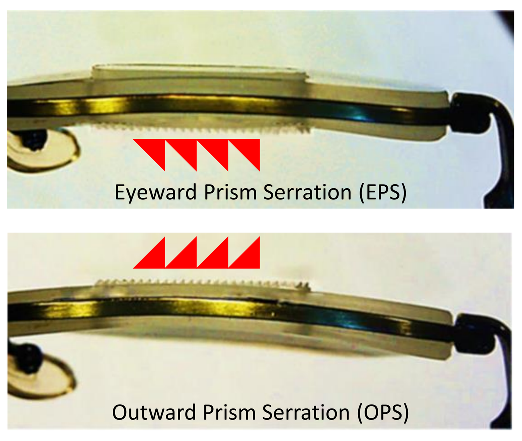
Prism Power Variation in High & Low Power Prisms

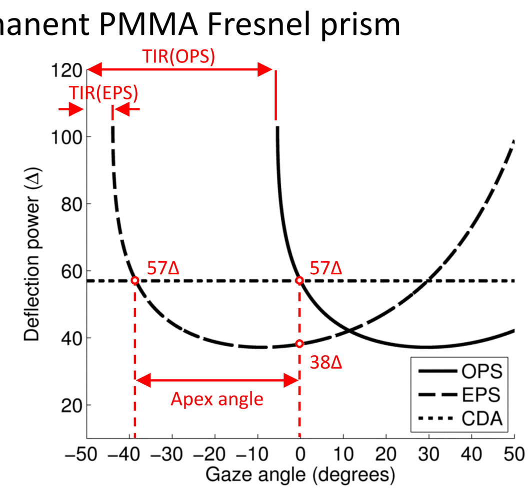


- **Low power prisms (i.e. 20Δ)**
  Prism power is almost constant (**CDA:** constant deflection angle)
  CDA ≈ Nominal power across a range of gaze shift (±15°)
- **High power prisms (i.e. 57Δ)**
  Prism power varies with angle of incidence within practical range of gaze movements

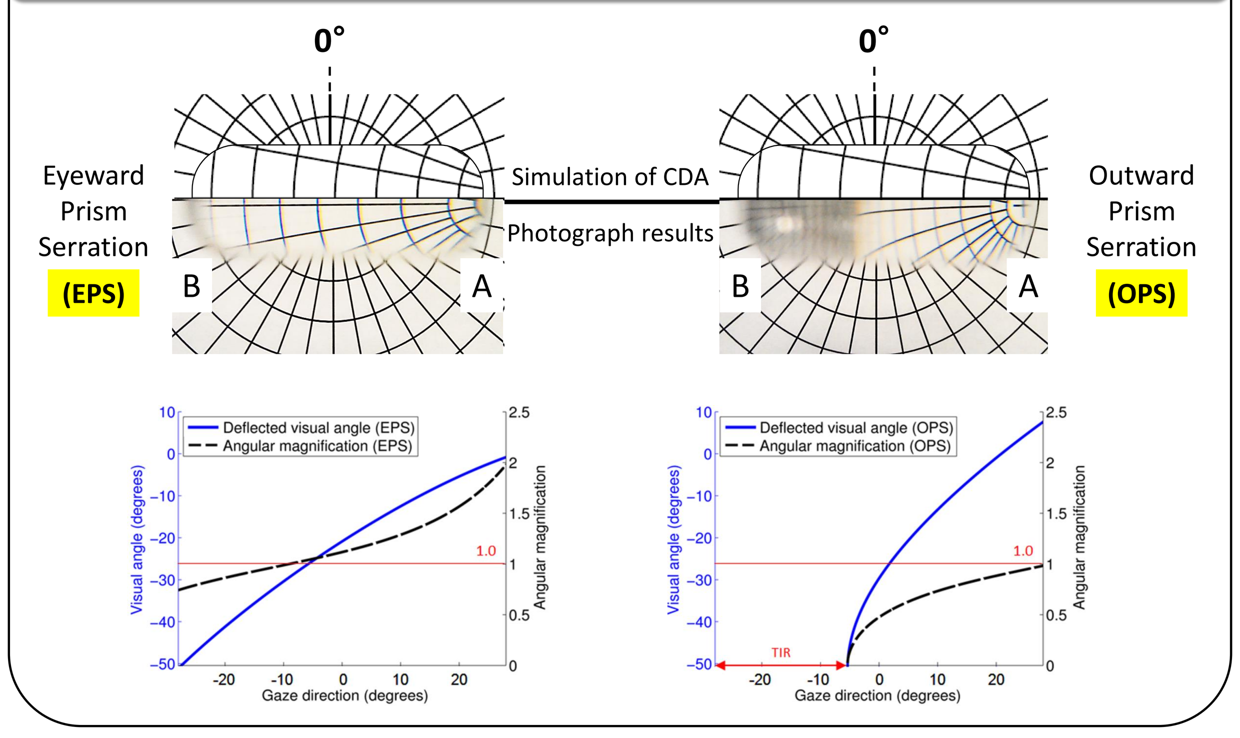
OPS and EPS Configurations

- Eyeward Prism Serration (**EPS**):
  Configuration Commonly used for press-on prism
- Outward Prism Serration (**OPS**):
  Configuration commonly used for permanent PMMA Fresnel prism



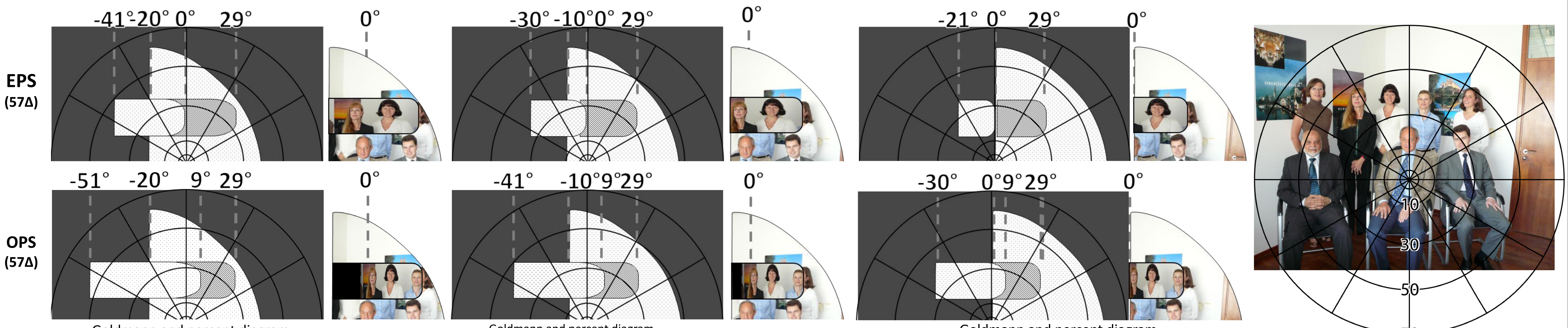


Magnification and Minification in OPS and EPS



Simulated Views in Primary Gaze, 10°and 20°Gaze Shifts to the Blind Side

- **With gaze shift to blind side**
  EPS: Magnification is almost constant (almost CDA), minimal distortion
  OPS: Increasing minification (distortion) until TIR, larger expansion dim and narrow
- **At primary gaze**
  EPS: Magnification, field expansion is smaller, apical scotoma is larger
  OPS: Minification, field expansion is larger, apical scotoma is smaller



Goldmann and percept diagram
Gaze shift toward blind side (20°)

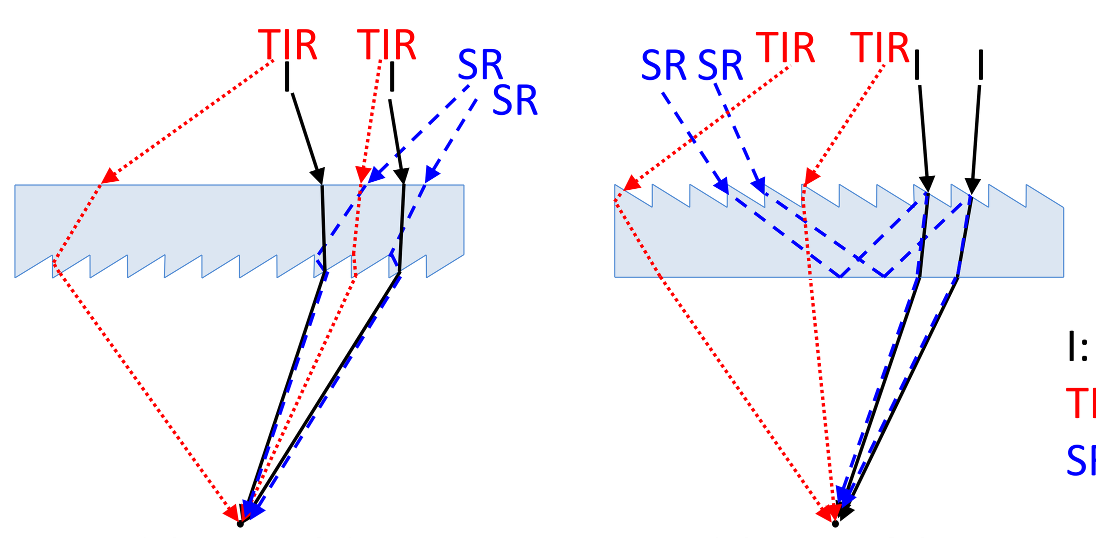
Goldmann and percept diagram
Gaze shift toward blind side (10°)

Goldmann and percept diagram
Primary gaze (0°)

Visual field and percept image

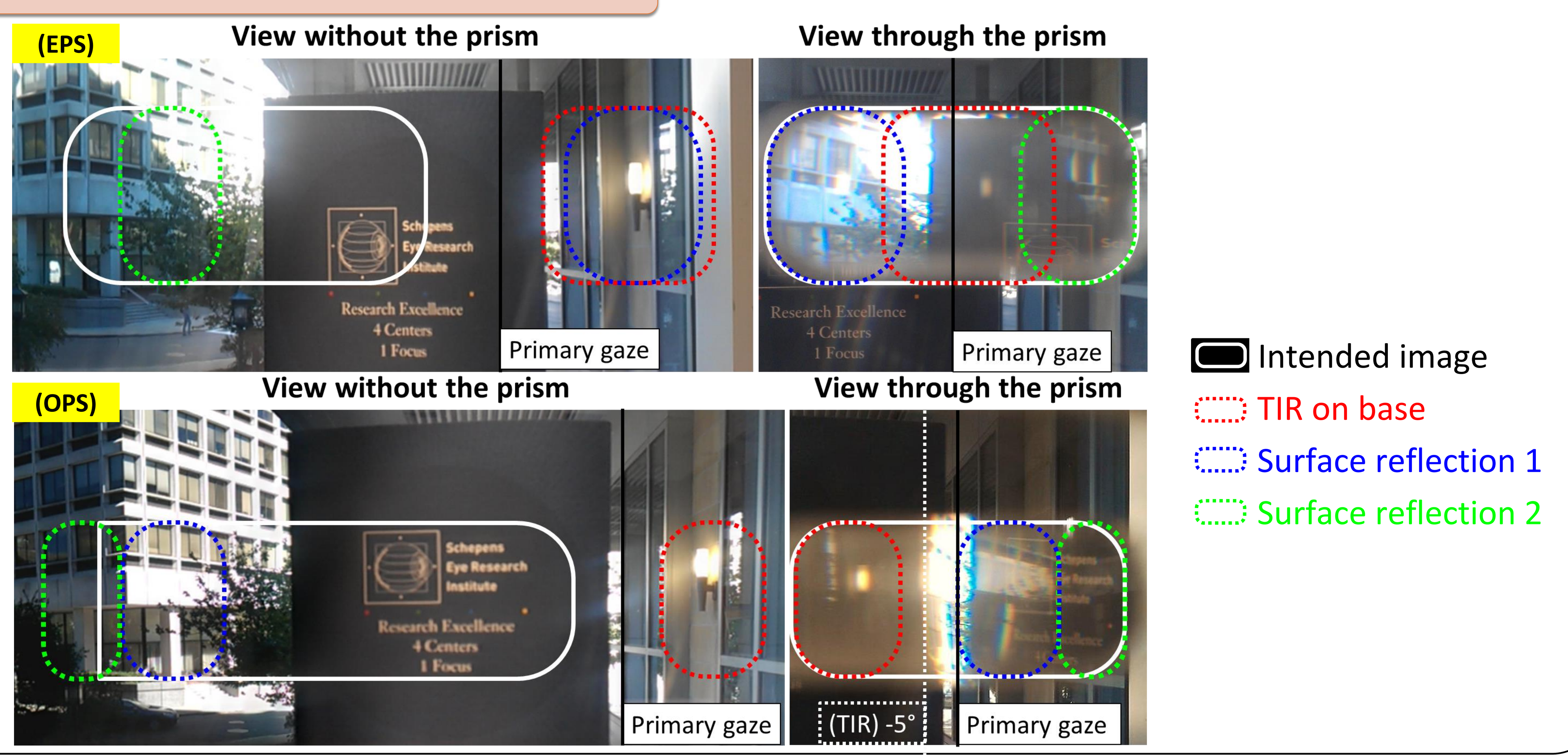
Spurious Reflections in 57Δ Fresnel prism

- **Monocular diplopia, monocular visual confusion, false alarms, & contrast reduction** can be caused by spurious reflections
- Meaningful reflections (**forming images**) in Fresnel prism
- Light rays split on surfaces into **transmitted** and **surface reflected** rays



Nodal point of the eye
Eyeward prism serration (EPS)

Nodal point of the eye
Outward prism serration (OPS)



Conclusion

- Prism power varies with angle of incidence
  – For low-power prisms (20Δ)
  the variations within the range of practical gaze shift (±15°) are very small
  – For high-power prisms (57Δ) The effective deflection varies with angle of incidence, and these effects must be considered when prescribing prisms for visual field expansion
- In **OPS** configuration
  – The field-of-view through the prism is **wider** and therefore more **compressed**
  – For 57Δ **TIR** blocks views beyond ≈5° into the blind side which **limits the effects of scanning**
  – **Apical Scotoma is smaller** (can cause diploipa)
  – At primary gaze the **TIR on base** appears in the **blind hemifield** while **dimmer surface reflections** appear at the **seeing hemifield**
- In **EPS** configuration prism power and its variability are reduced
  – The actual prism view is slightly **magnified** by the reduced prism power. **The effect of scanning is not limited**
  – At primary gaze the **TIR on base** and the **surface reflection** appear in the **visible hemifield** and can cause **visual confusion, diplopia, & bright false alarms**

Acknowledgement and References

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- Dr. Peli has patent rights (assigned to Schepens Eye Research Institute) for the peripheral oblique prisms (licensed to Chadwick Optical)

1) E. Peli (2000)
Field expansion for homonymous hemianopia by optically-induced peripheral exotropia,
Optometry and Vision Science, **77**(9), 453-464

2) E. Peli (2008)
Peripheral Field Expansion Device, *United States patent* 7,374,284

3) H. L. Apfelbaum, N. C. Ross, A. B. Bowers, E. Peli (2013)
Considering optical scotomas, confusion, and diplopia when prescribing prisms for homonymous hemianopia,
Translational Vision Science & Technology **2**(4), article 2

4) J. -H. Jung, E. Peli (2014)
Impact of high power and angle of incidence on prism corrections for visual field loss,
***Optical Engineering* 53(6), 061707, Open Access**