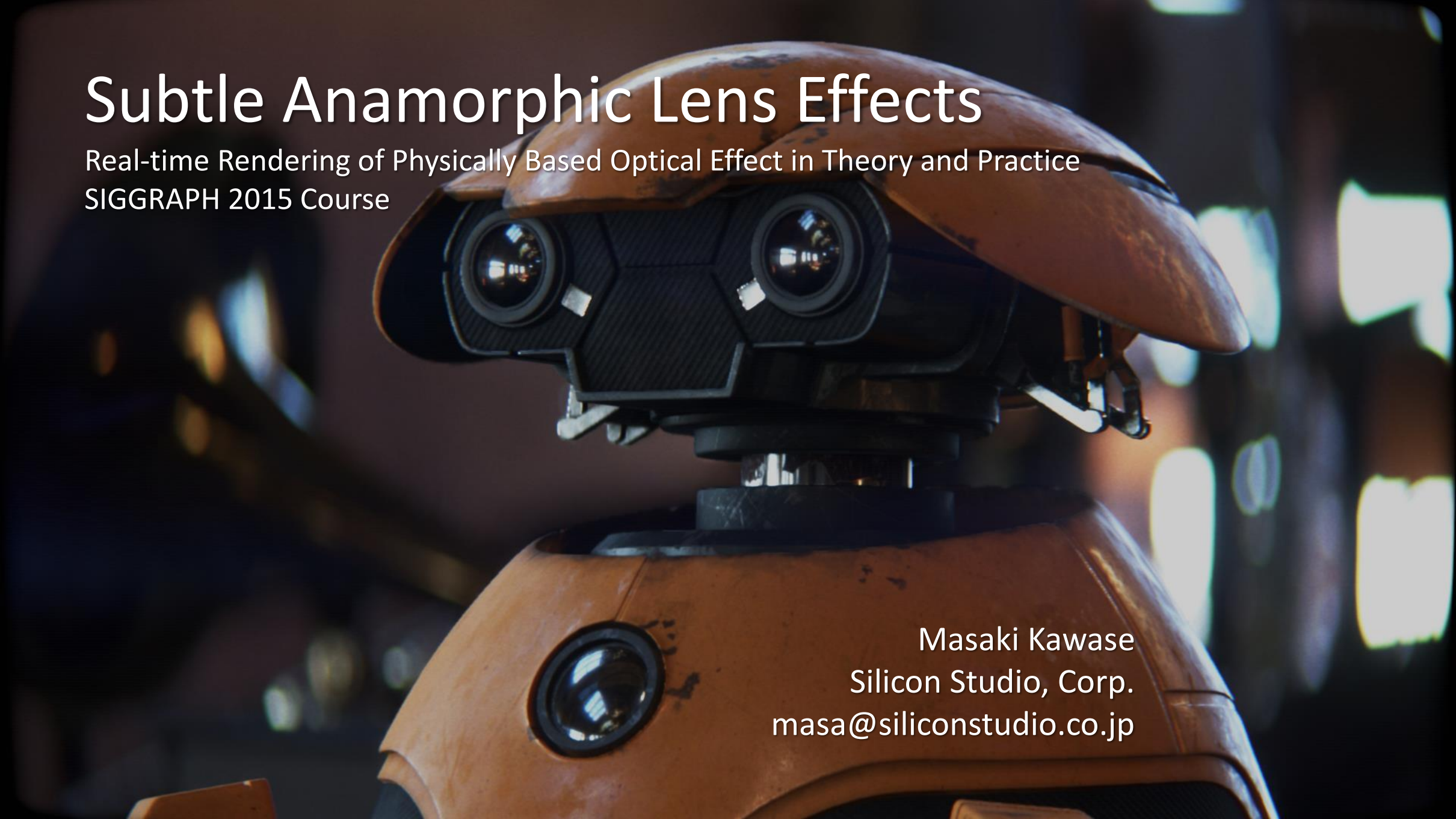


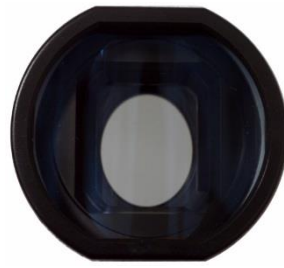
# Subtle Anamorphic Lens Effects

Real-time Rendering of Physically Based Optical Effect in Theory and Practice  
SIGGRAPH 2015 Course

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Silicon Studio, Corp.  
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# Anamorphic Lens



- To implement wide vision using the standard film format
  - Project wide image onto the sensor with horizontal compression
  - When screening, the image is stretched horizontally



# Anamorphic Lens Effects

- Well-known effects
  - Horizontal lens flare and ghosts (streaks)
  - Oval aperture bokeh
- Less-known effects
  - Horizontally stretched lens flare
  - Horizontally stretched film grain
  - Anamorphic astigmatism
  - CA of horizontal magnification
  - Cylindrical lens distortion
  - Vignetting by oval aperture
  - And more ...



Panasonic LA7200 Anamorphic Lens Flare by Andrei Jikh  
<http://vimeo.com/9493224#at=0>



Anamorphic Lens Shots - Before & After  
<http://vimeo.com/16350276>

# Importance of Less-known Effects

- Helpful to create distinctive atmosphere
  - Each effect on its own is subtle
  - But together, they will affect the overall atmosphere



# Standard Lens Simulation



# Anamorphic Lens Simulation (with Well-known Effects)





# Anamorphic Lens Simulation (Adding Less-known Effects)

\*Exaggerated for presentation purposes



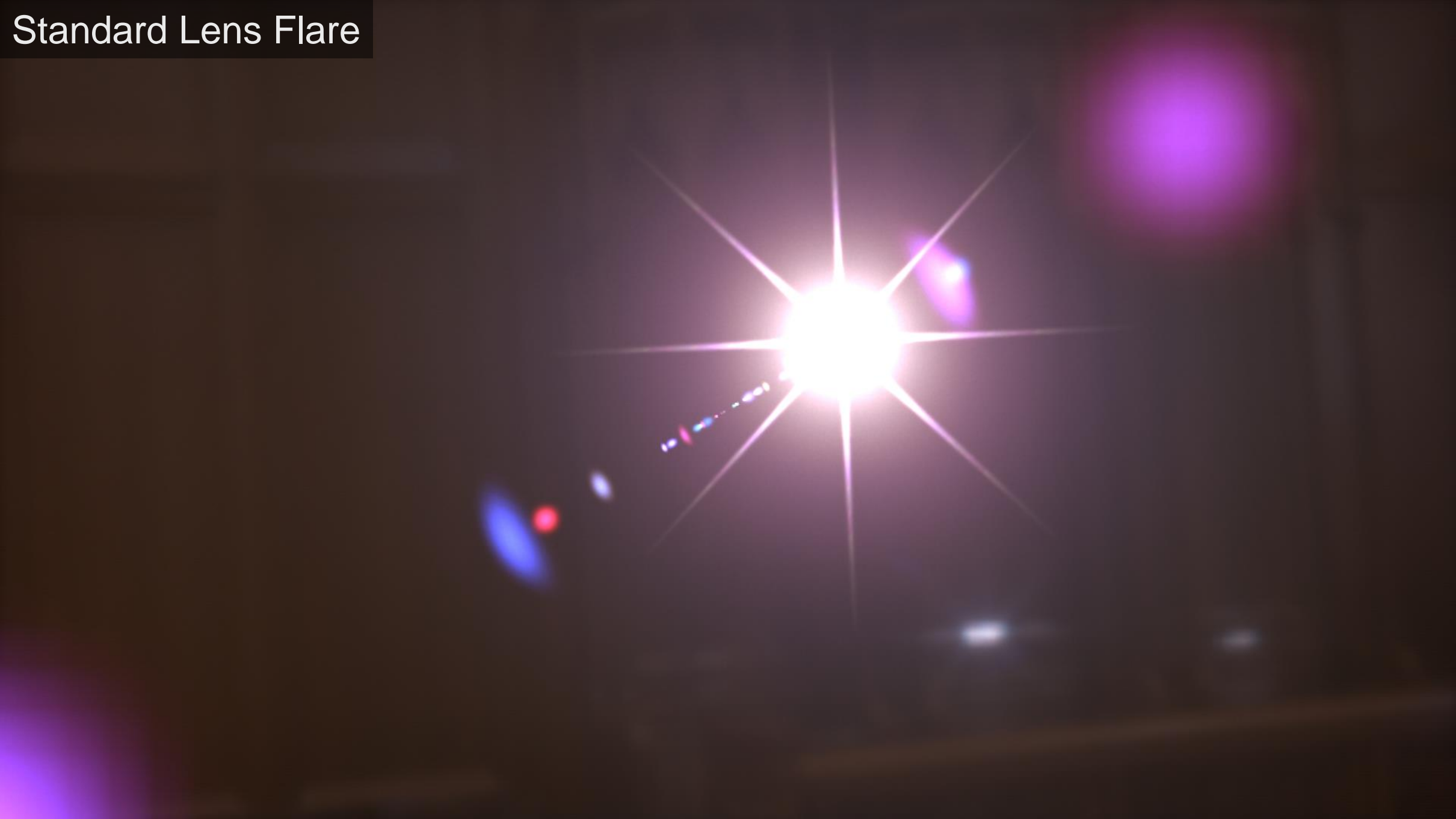
# Horizontally Stretched Lens Flare and Film Grain



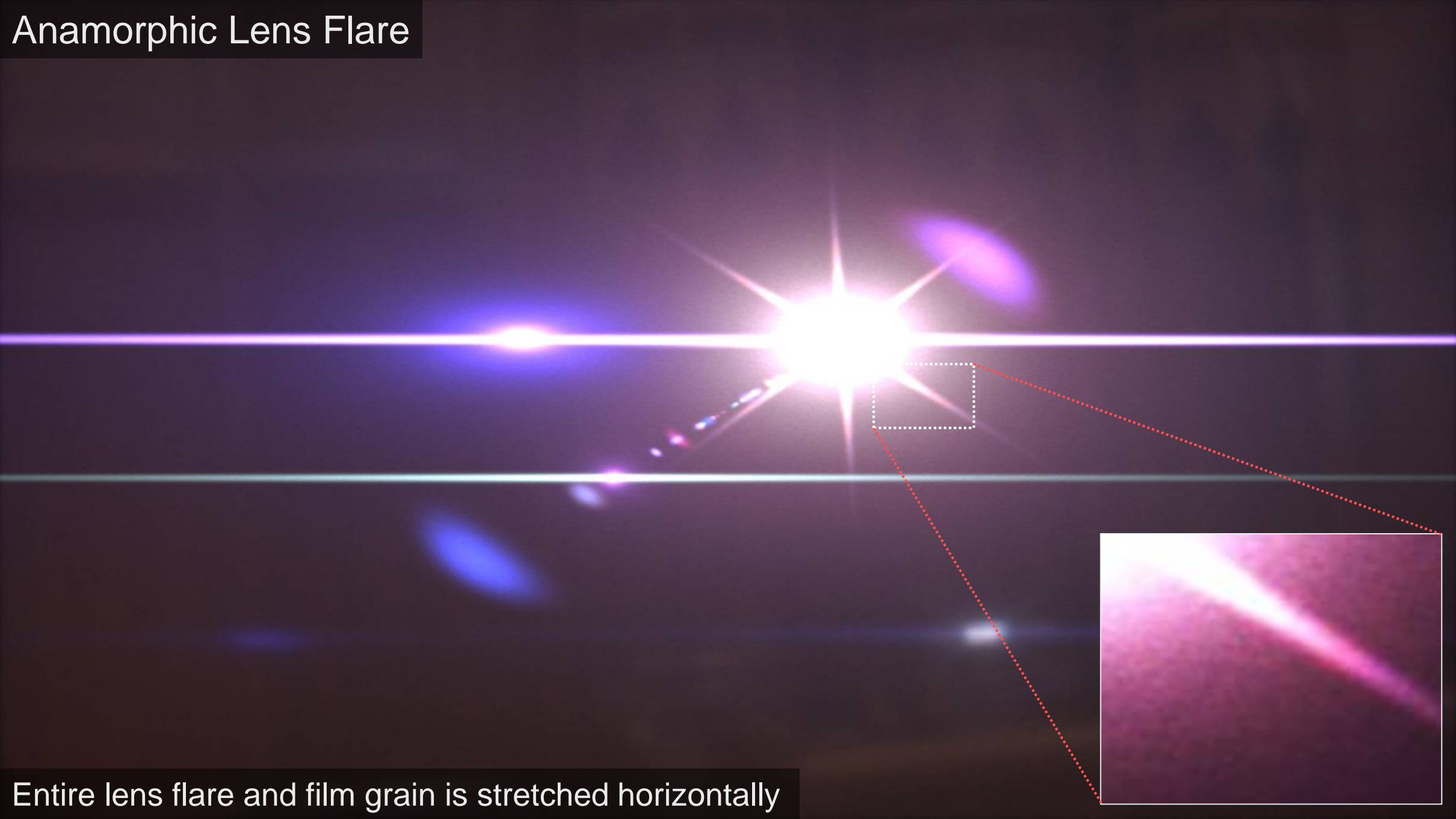
# Horizontally Stretched Flare and Film Grain

- The effects are stretched by anamorphic projector lens
- Implementation
  - Shrink working buffer width for the flare
    - Render flare normally
    - The results become stretched automatically
  - Scale the noise texcoord horizontally for the grain

# Standard Lens Flare



# Anamorphic Lens Flare



Entire lens flare and film grain is stretched horizontally

# Film Grain is also Stretched



Standard lens

Anamorphic lens

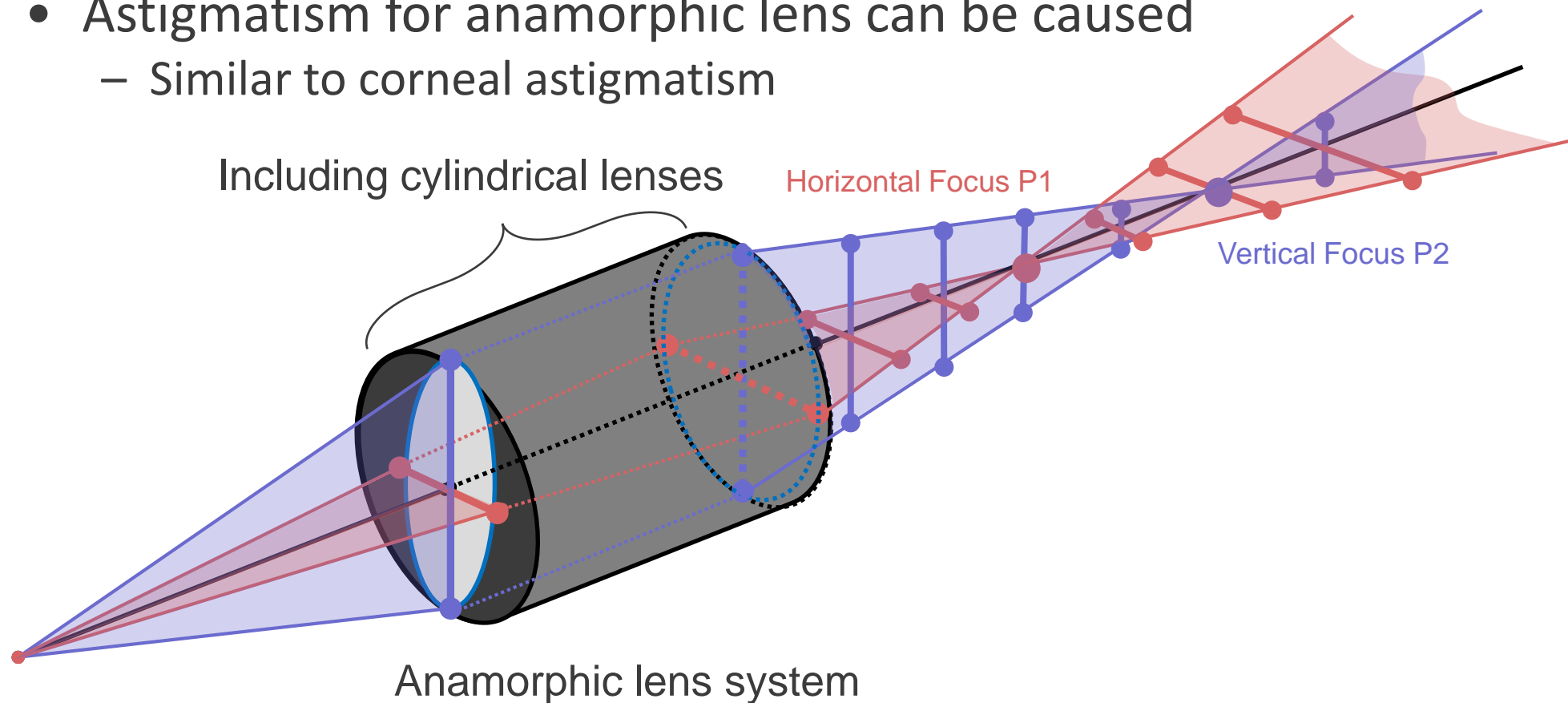
Exaggerated for presentation



# Anamorphic Astigmatism

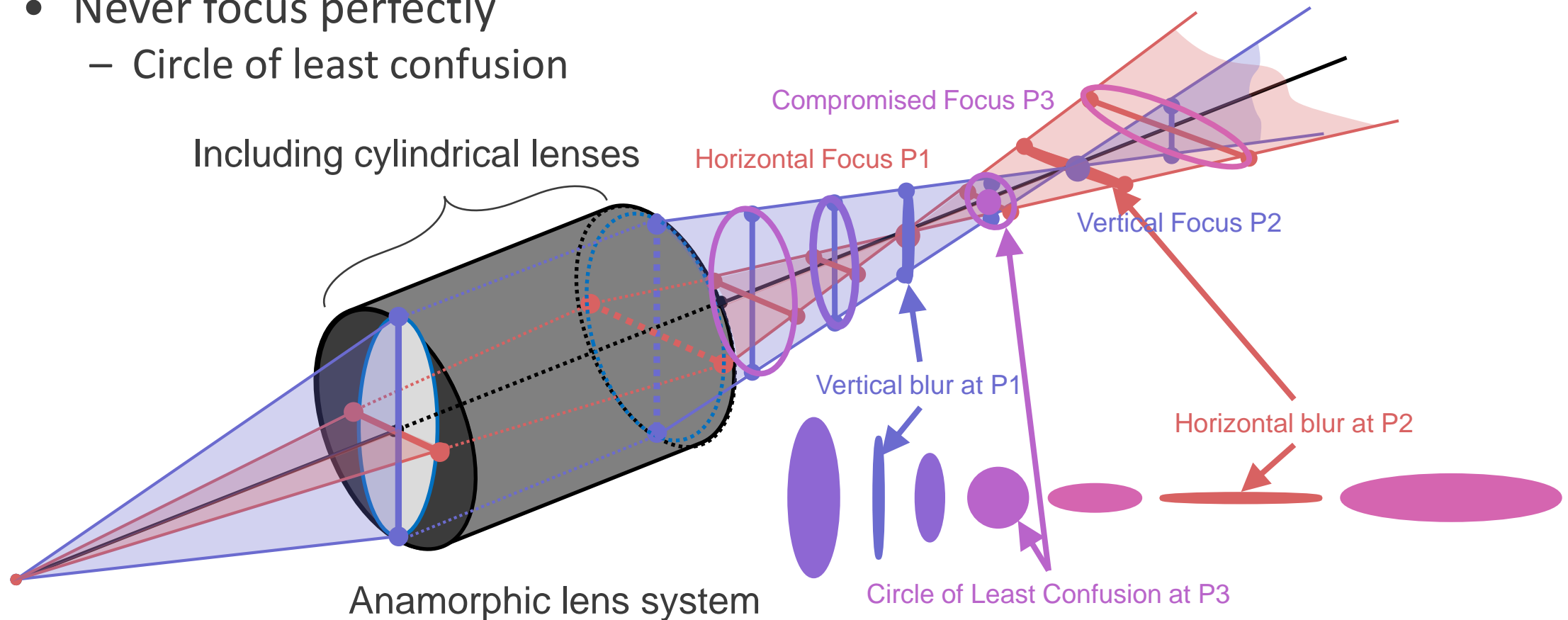
# Because of Cylindrical Lenses

- Anamorphic lens systems include cylindrical lenses
- Astigmatism for anamorphic lens can be caused
  - Similar to corneal astigmatism



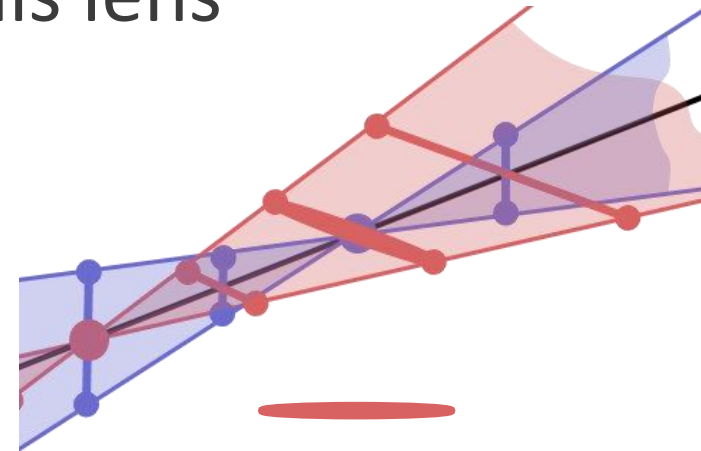
# Linear Blur by Astigmatism

- Horizontal or vertical focus generates linear blur
- Never focus perfectly
  - Circle of least confusion



# Vertical Focus

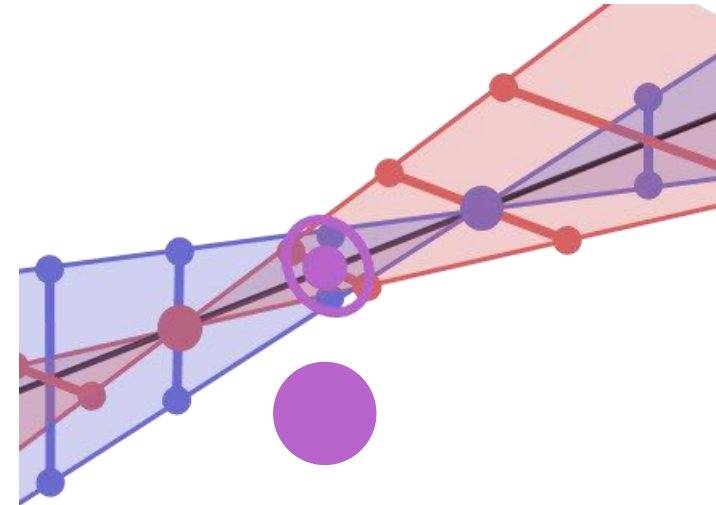
- Horizontal blur as back bokeh in this lens





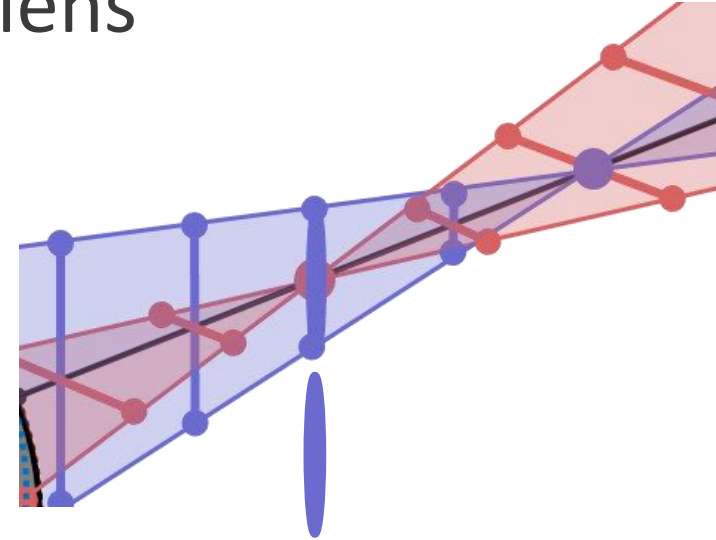
# Circle of Least Confusion Position

- Cannot focus perfectly



# Horizontal Focus

- Vertical blur as front bokeh in this lens





Vertical Focus  
Horizontal blur as back bokeh in this lens





Circle of Least Confusion  
Cannot focus perfectly





Horizontal Focus  
Vertical blur as front bokeh in this lens

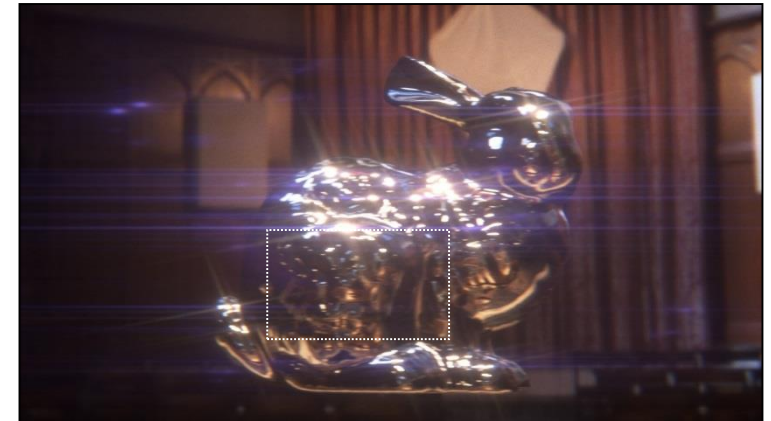
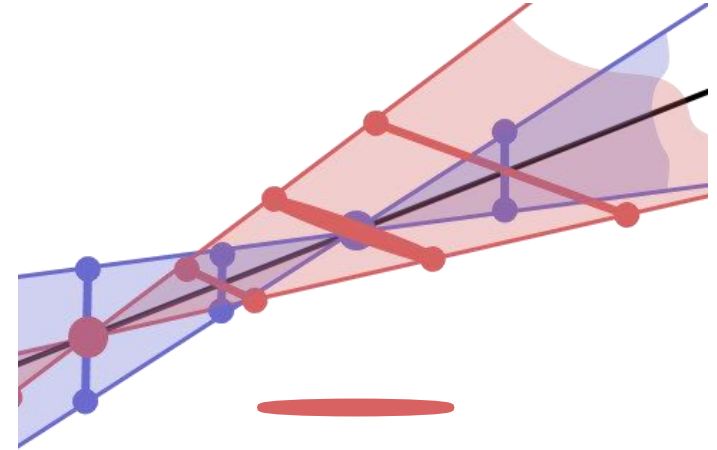


# Implementation of Astigmatism

- Offset the horizontal and vertical focal planes in opposite directions by a little amount
- Calculate horizontal and vertical CoCs separately

# Result: Vertical Focus

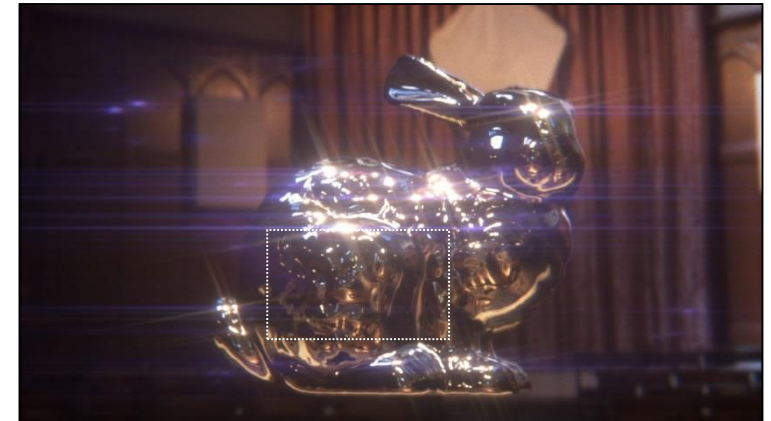
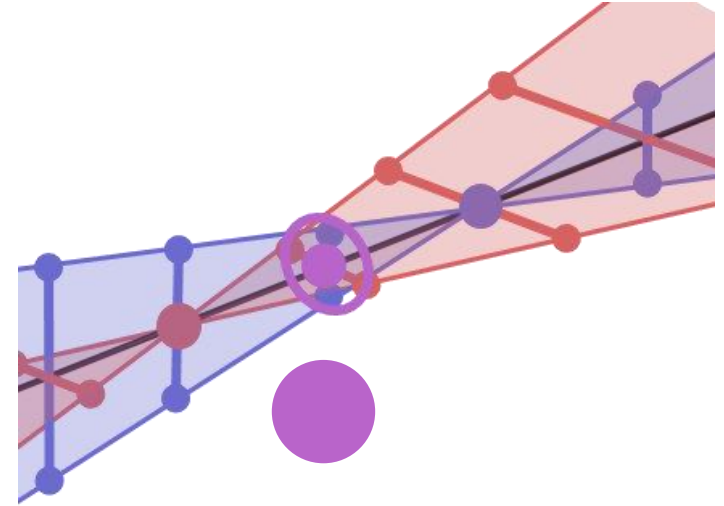
- Horizontal blur as back bokeh





# Result: Circle of Least Confusion

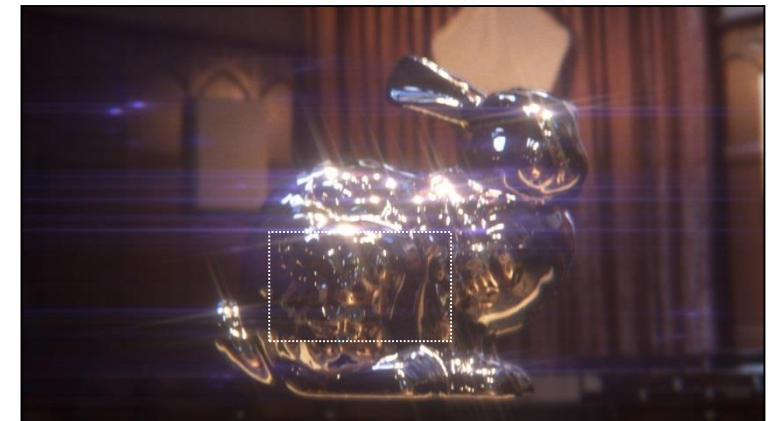
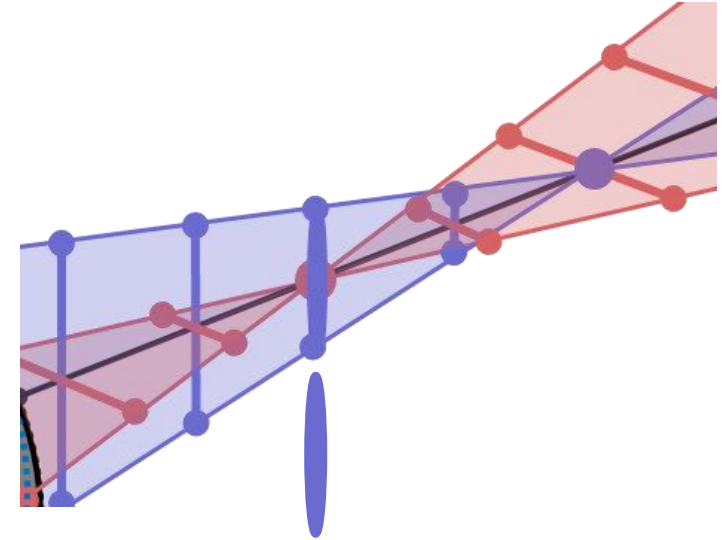
- Cannot focus perfectly



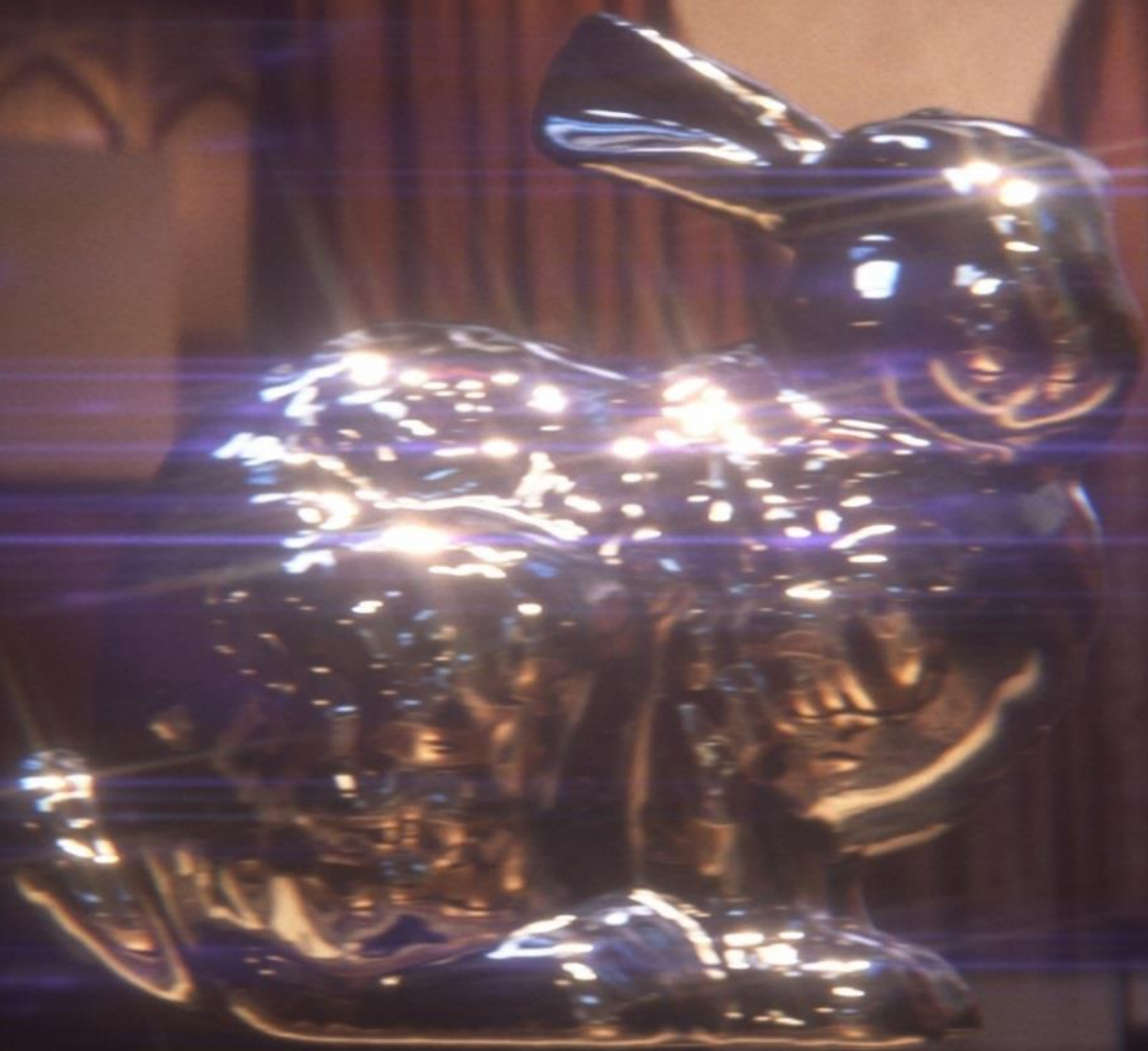


# Result: Horizontal Focus

- Vertical blur as front bokeh

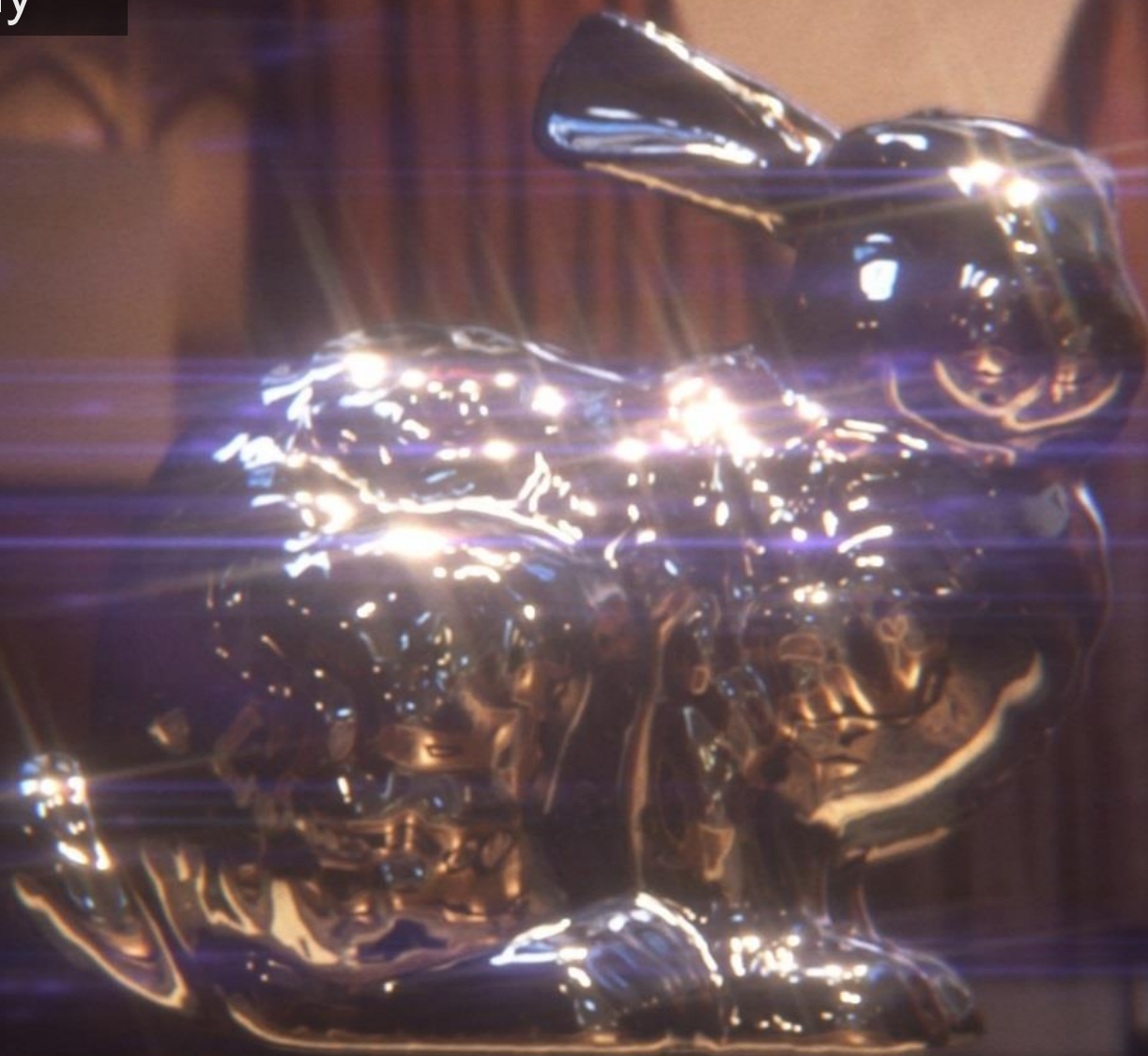


Vertical Focus  
Horizontal blur

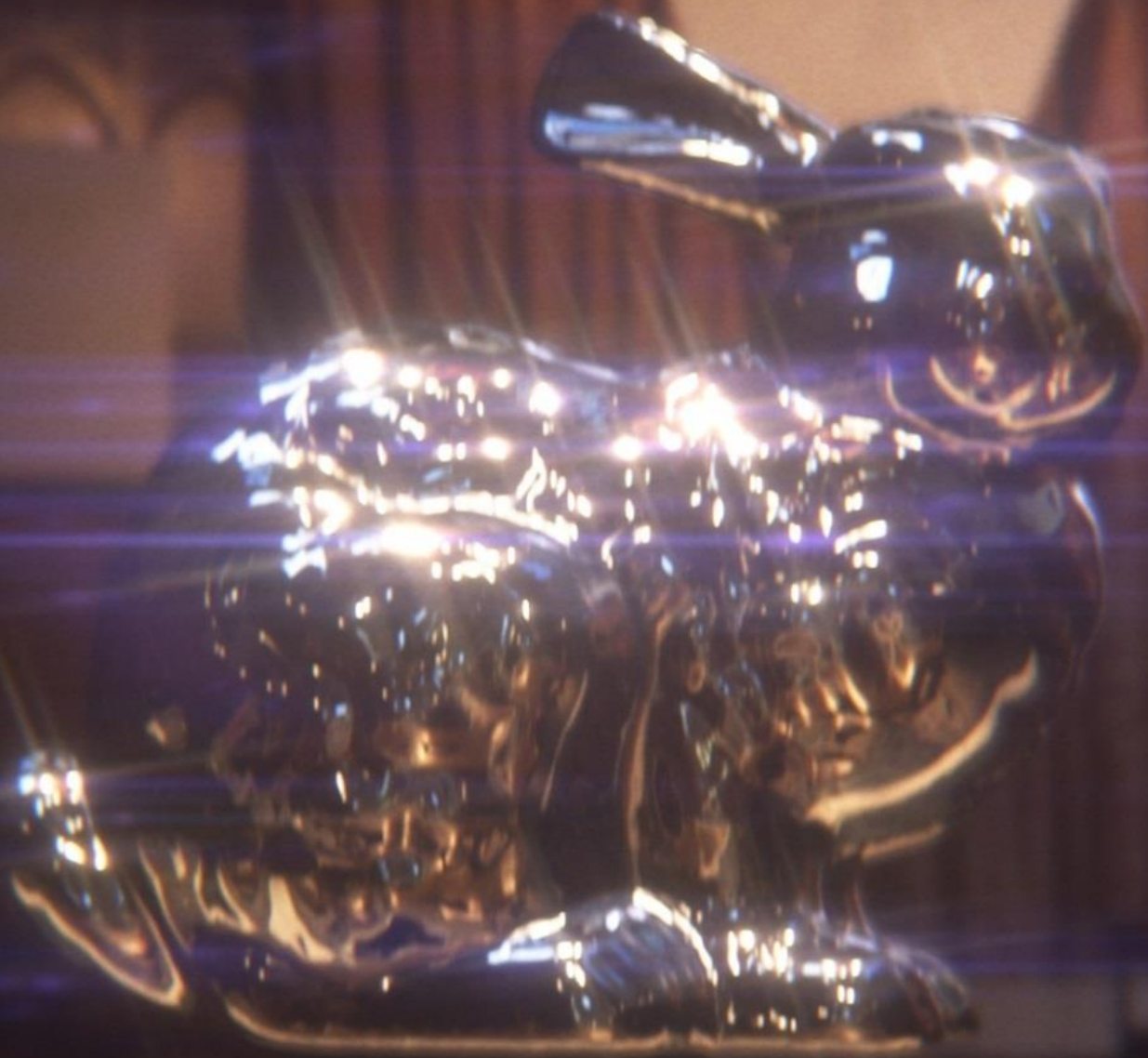




Circle of Least Confusion  
Cannot focus perfectly



Horizontal Focus  
Vertical blur

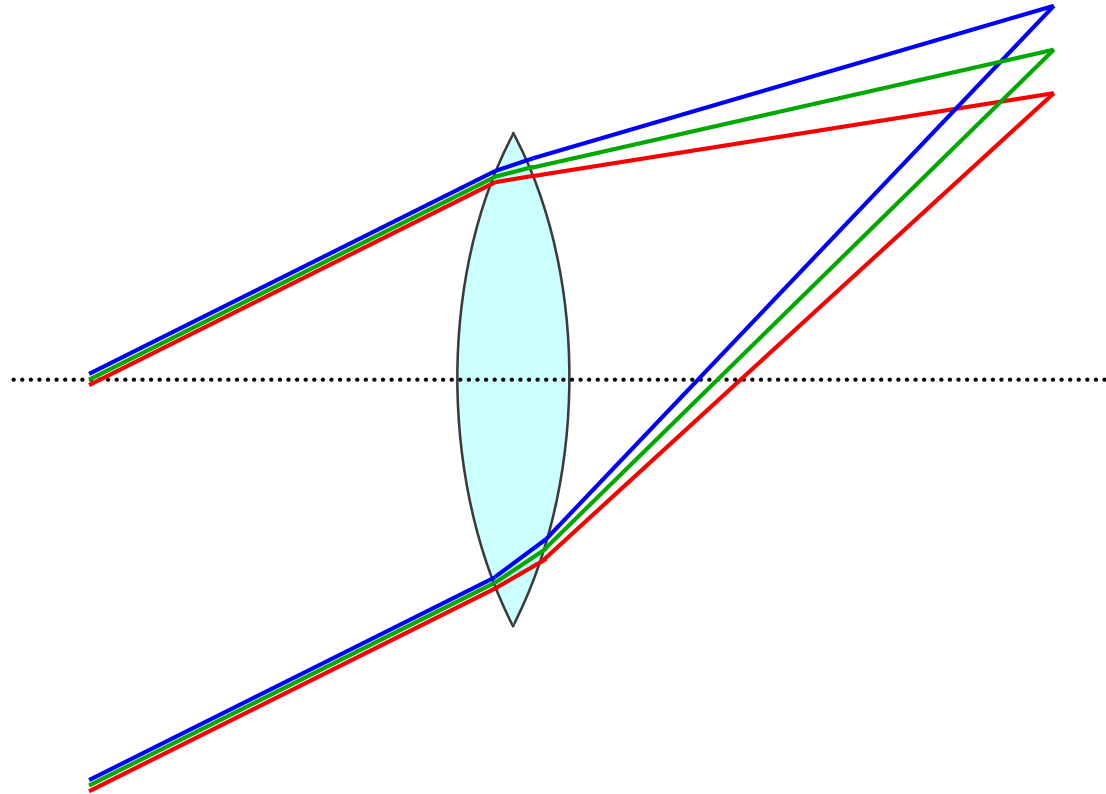


# Aberrations by Cylindrical Lenses

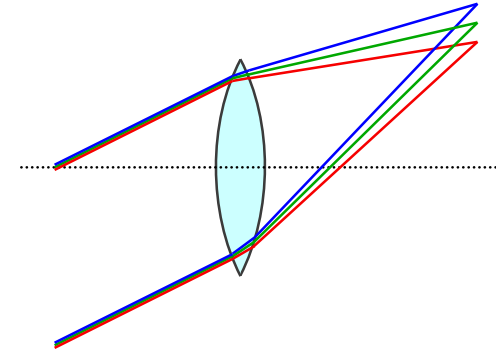


# CA of Magnification

- Optical Magnification ' $M$ ' differs by wavelength



# CA of Magnification (cont'd)



Chromatic Aberration  
of Magnification  
Chromatic Aberration  
of Magnification  
Chromatic Aberration  
of Magnification

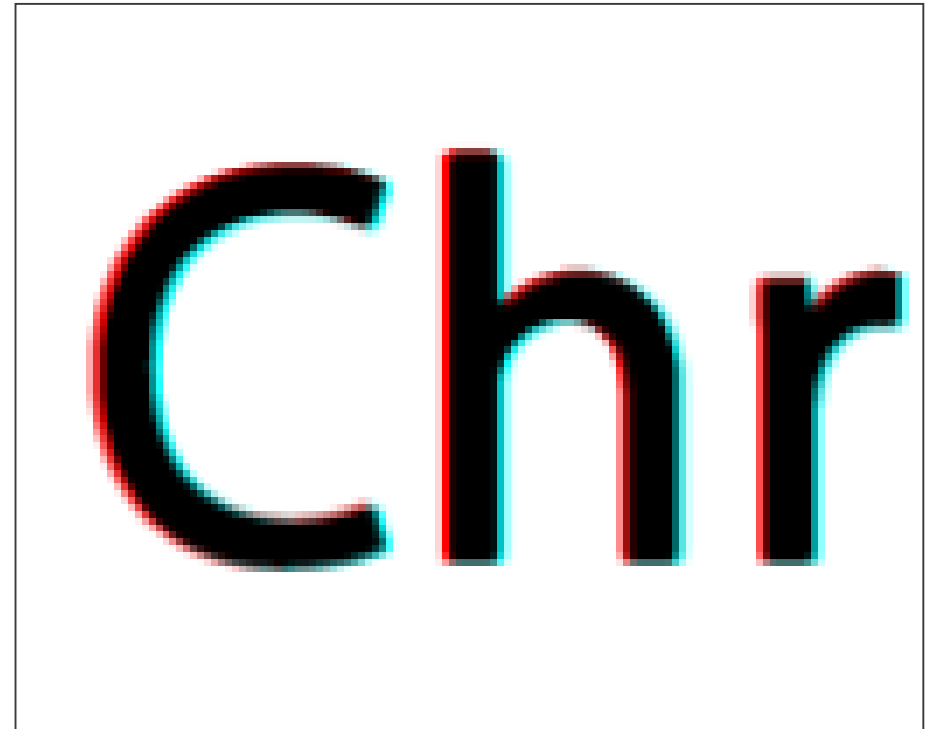
Ch

# CA of Horizontal Magnification

- Apply CA of magnification only in horizontal direction



CA of magnification



CA of horizontal magnification



# Anamorphic Lens



# Anamorphic Lens



CA of horizontal magnification



# Standard Lens





Cylindrical Lens Distortion  
Horizontally strong barrel distortion



Anamorphic lens

WEBIS  
by Silicon Studio

Silicon Studio



Standard Lens Distortion  
Barrel distortion



Standard lens

WEBIS  
by Silicon Studio

Silicon Studio

# Conclusion



# Conclusion

- Anamorphic lenses yield various effects
  - Well-known and less-known effects
- Less-known effects should not be ignored
  - Each effect on its own is subtle
  - But together, they will affect the overall atmosphere

# Standard Lens



# Anamorphic Lens (with Well-known Effects)





# Anamorphic Lens Simulation (Adding Less-known Effects)

\*Exaggerated for presentation purposes





# References

- Kawase, M. “Camera, Optics Theory and Post Effects for Renderists.” *Computer Entertainment Developers Conference, 2007.*
- Kawase, M. “Practical Implementation of Cinematic Lens Effects.” *Computer Entertainment Developers Conference, 2012.*