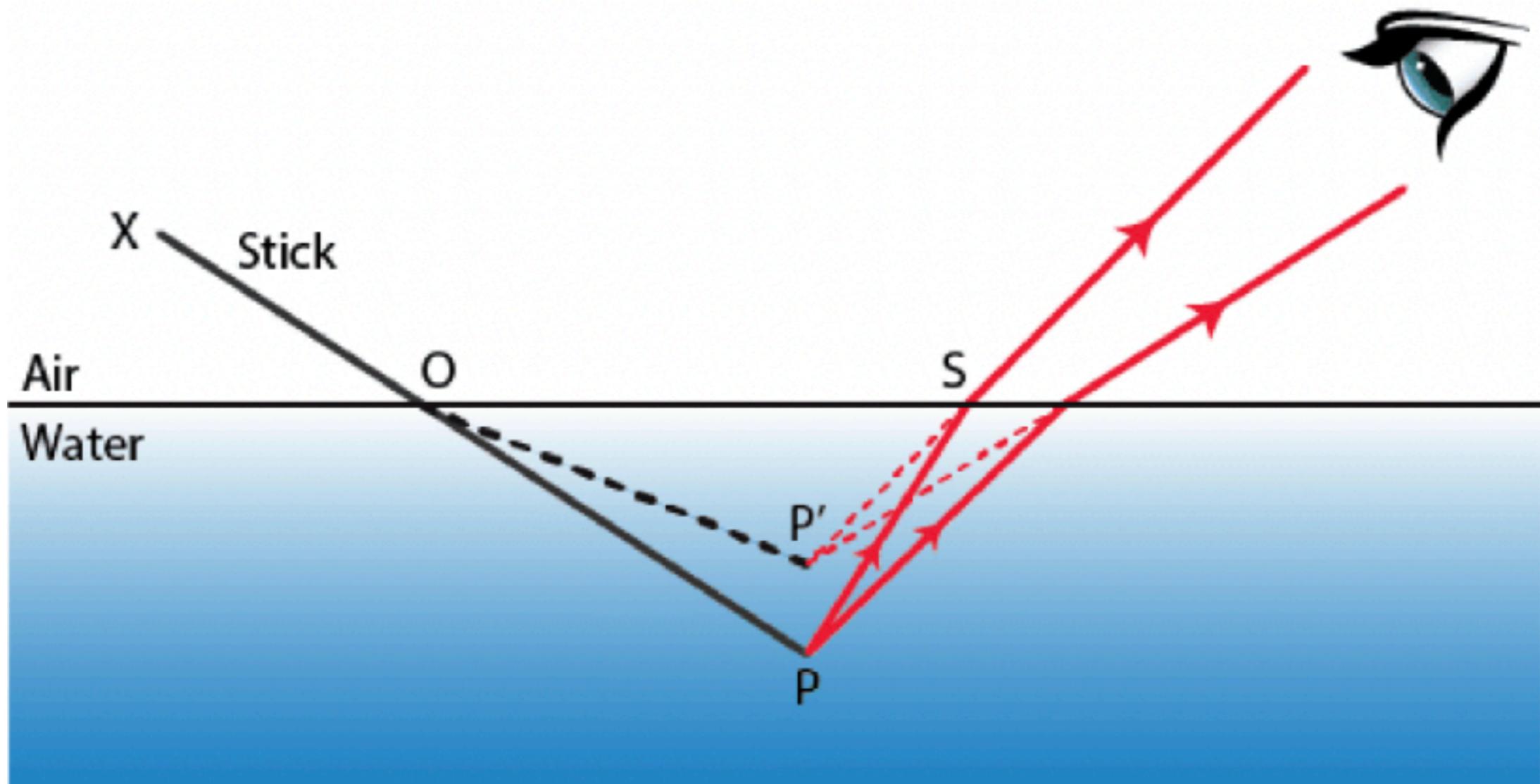


**How sharp is your lens?**

## Light bends through water and glass



What causes image blur?

# Lenses are not perfect and contain many aberrations

Chromatic -

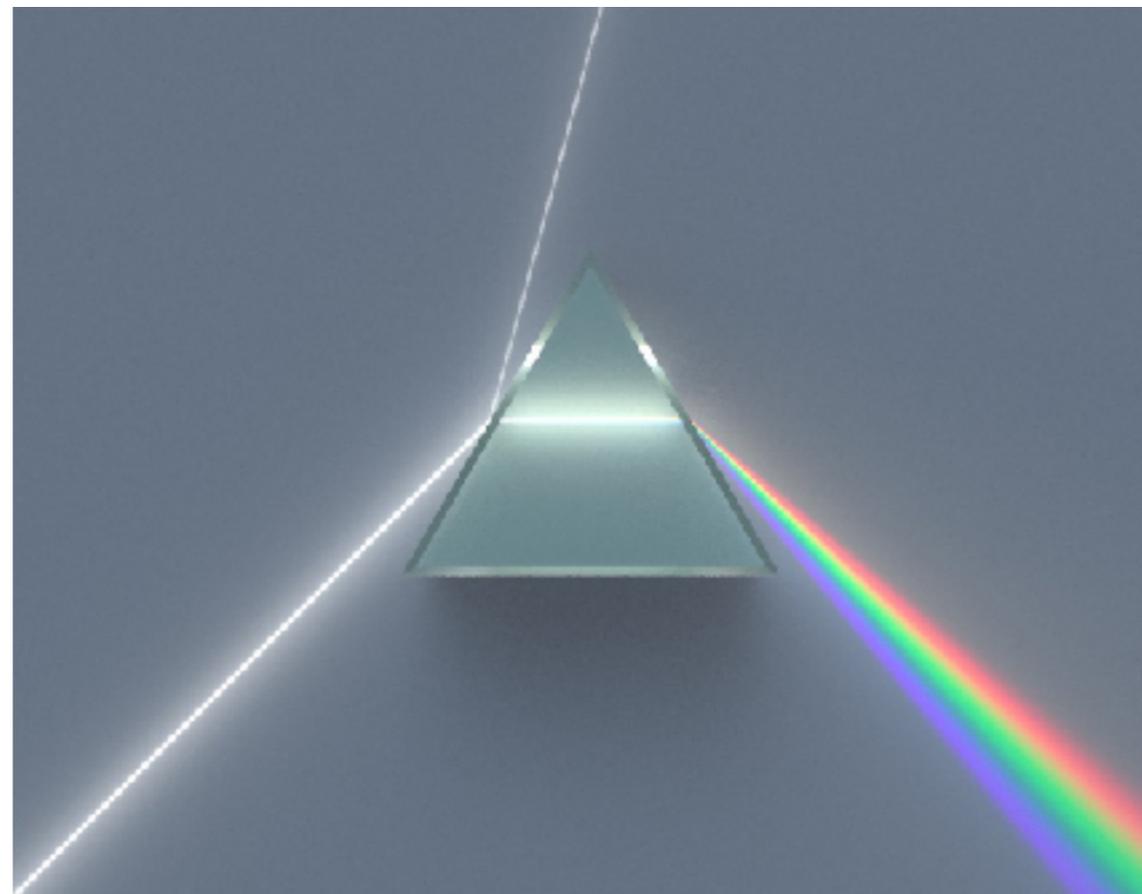
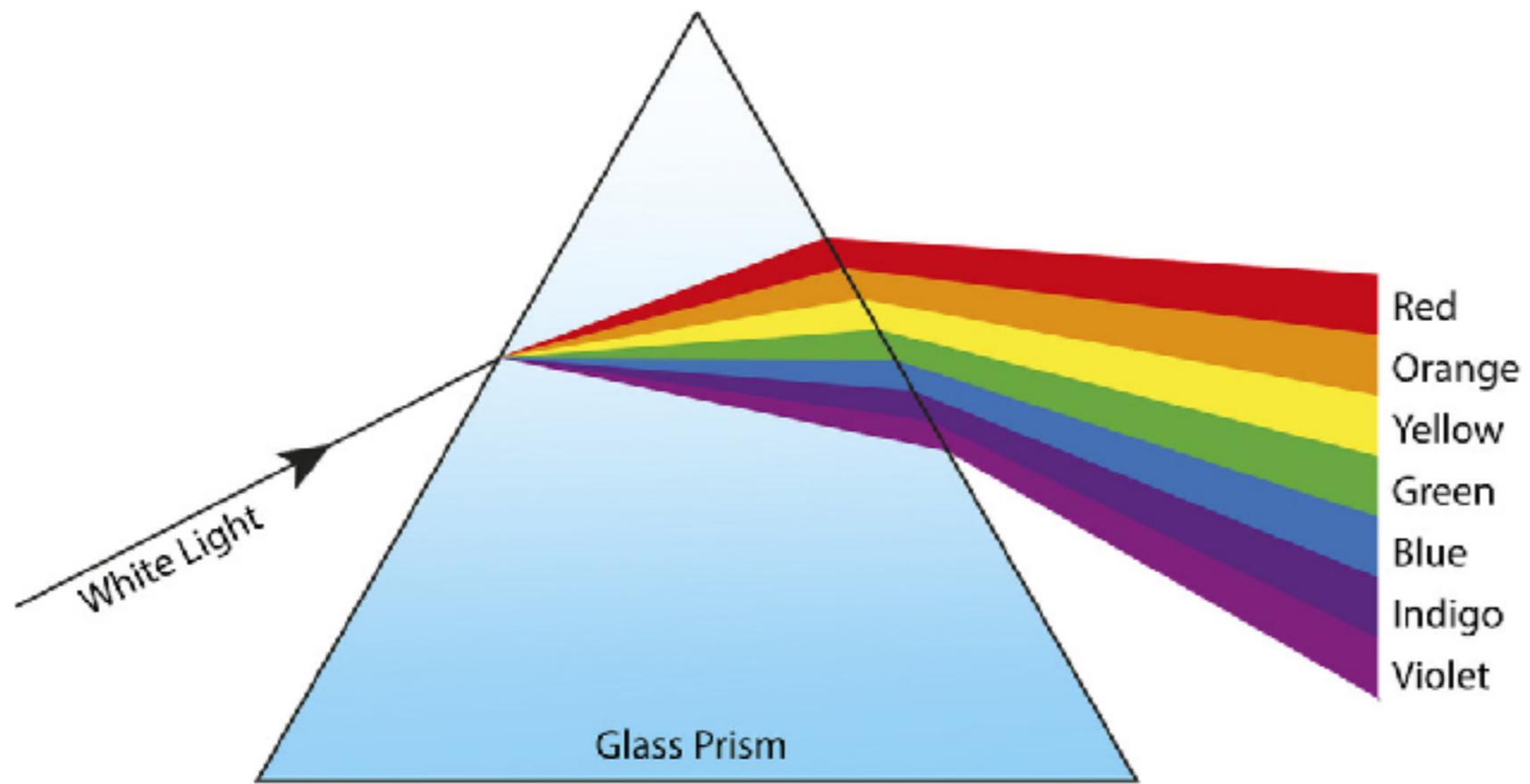
Colours not focussing at the same point

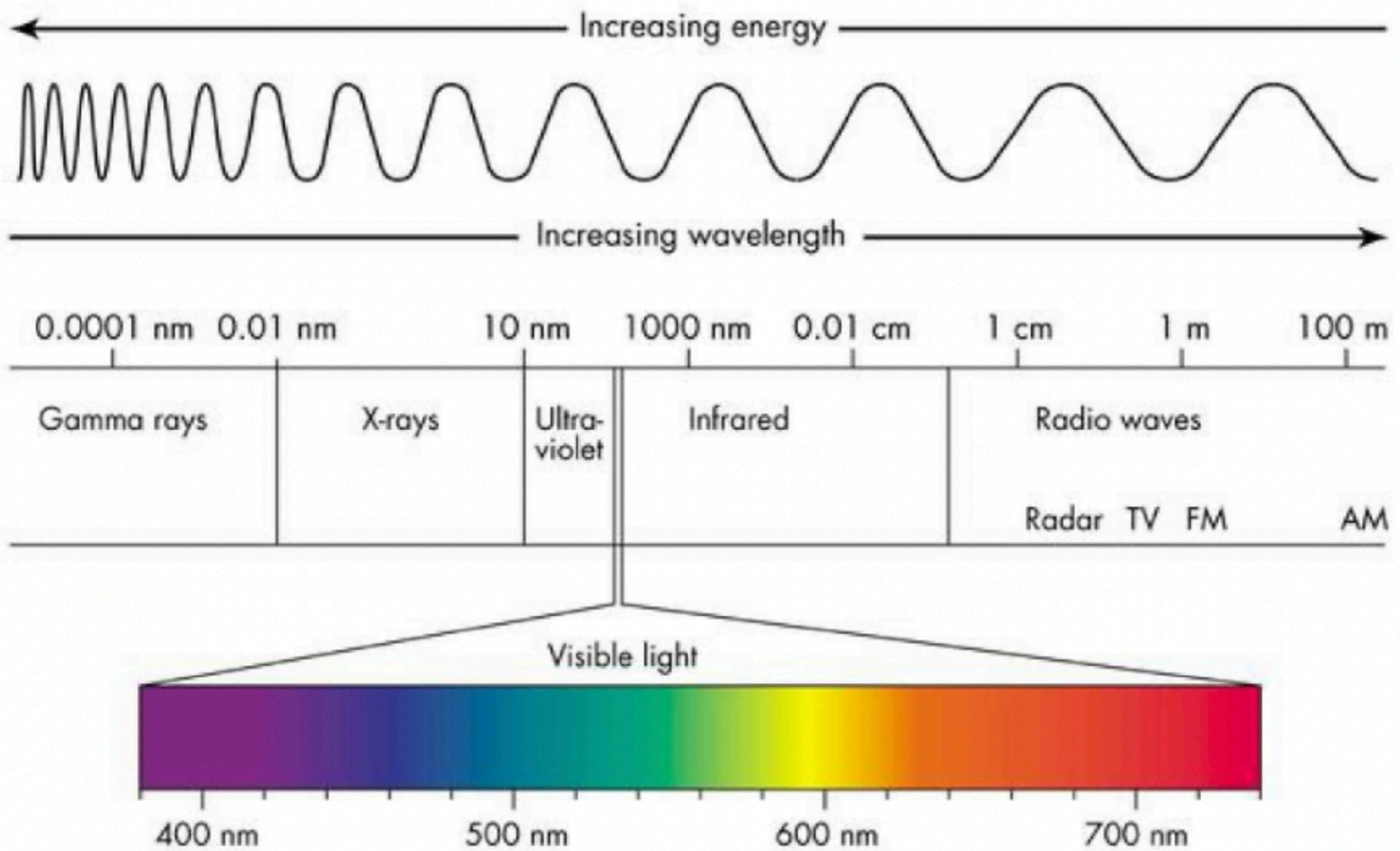
Monochromatic -

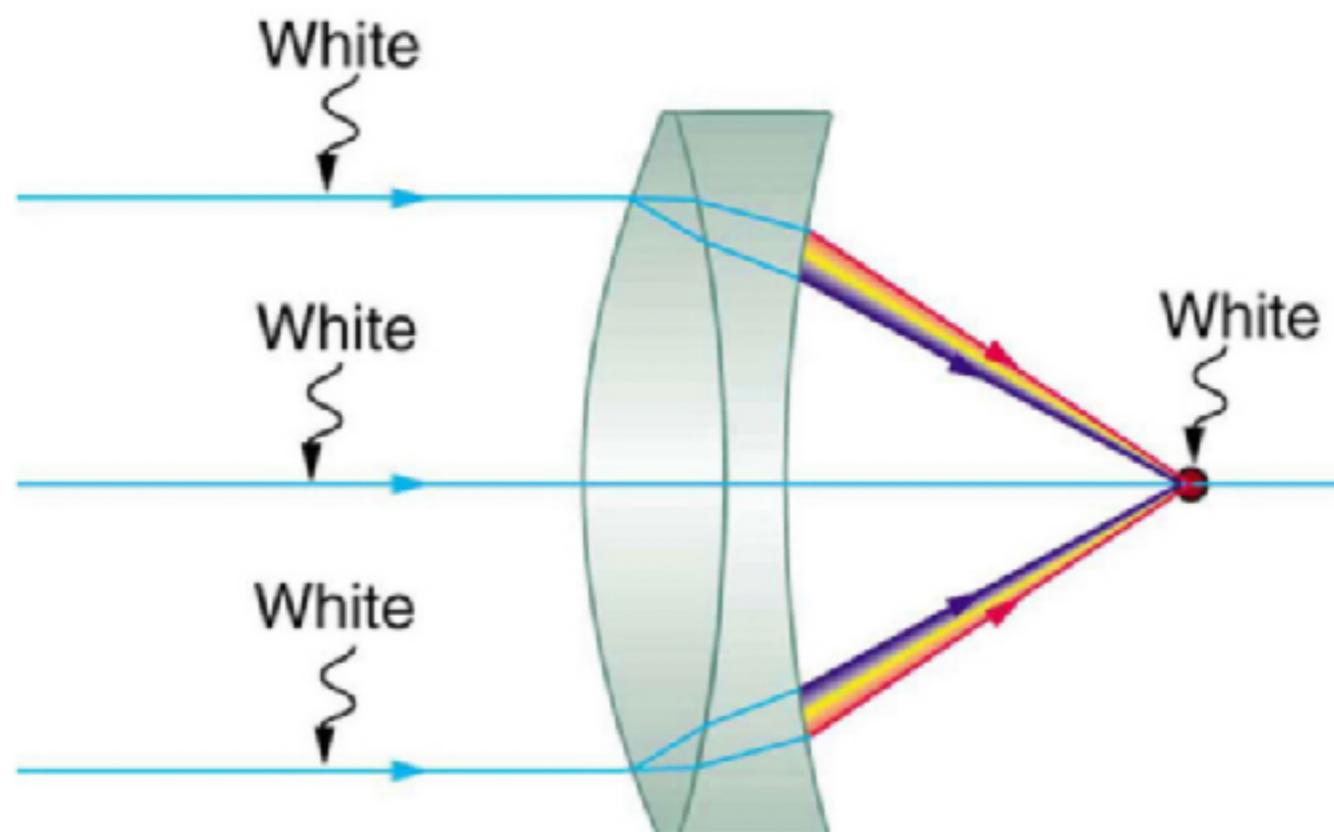
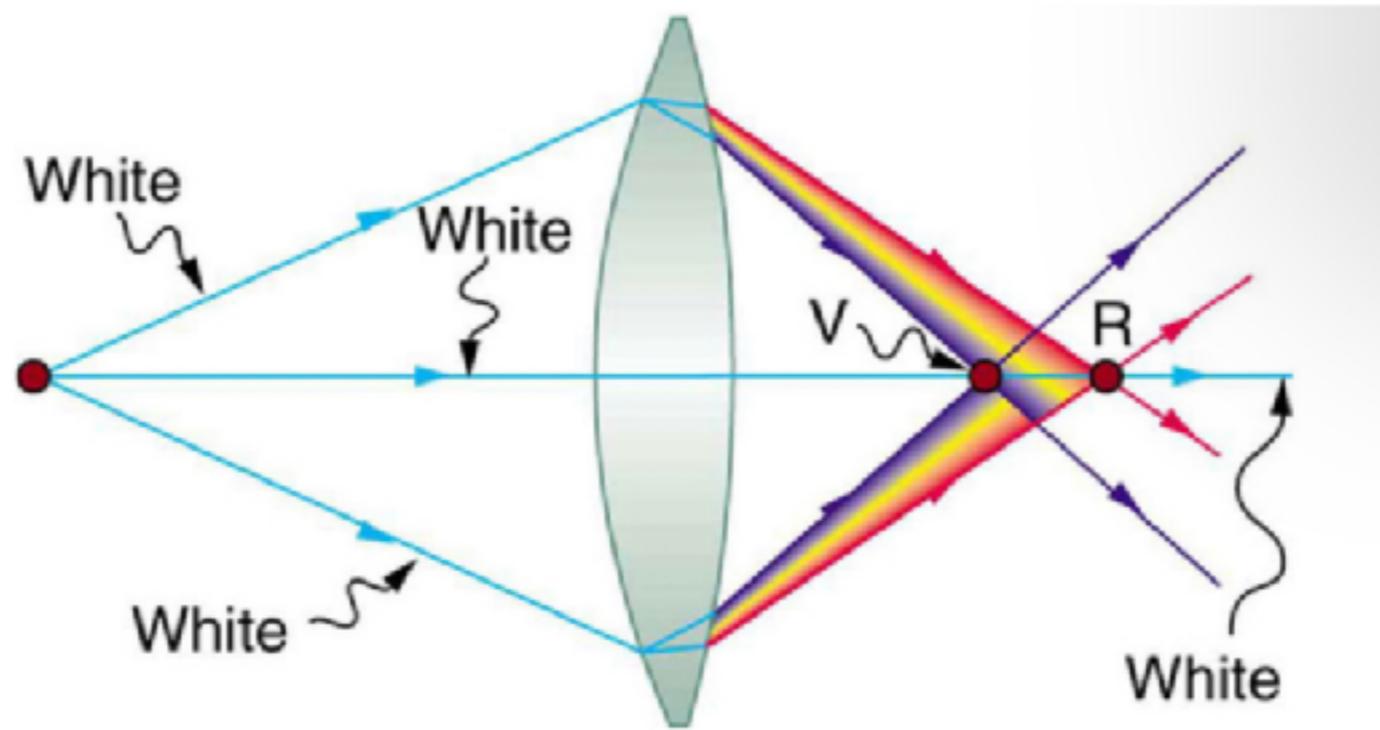
Spherical, Coma, Astigmatism, Curvature, Distortion

Focus performance at centre and at edge

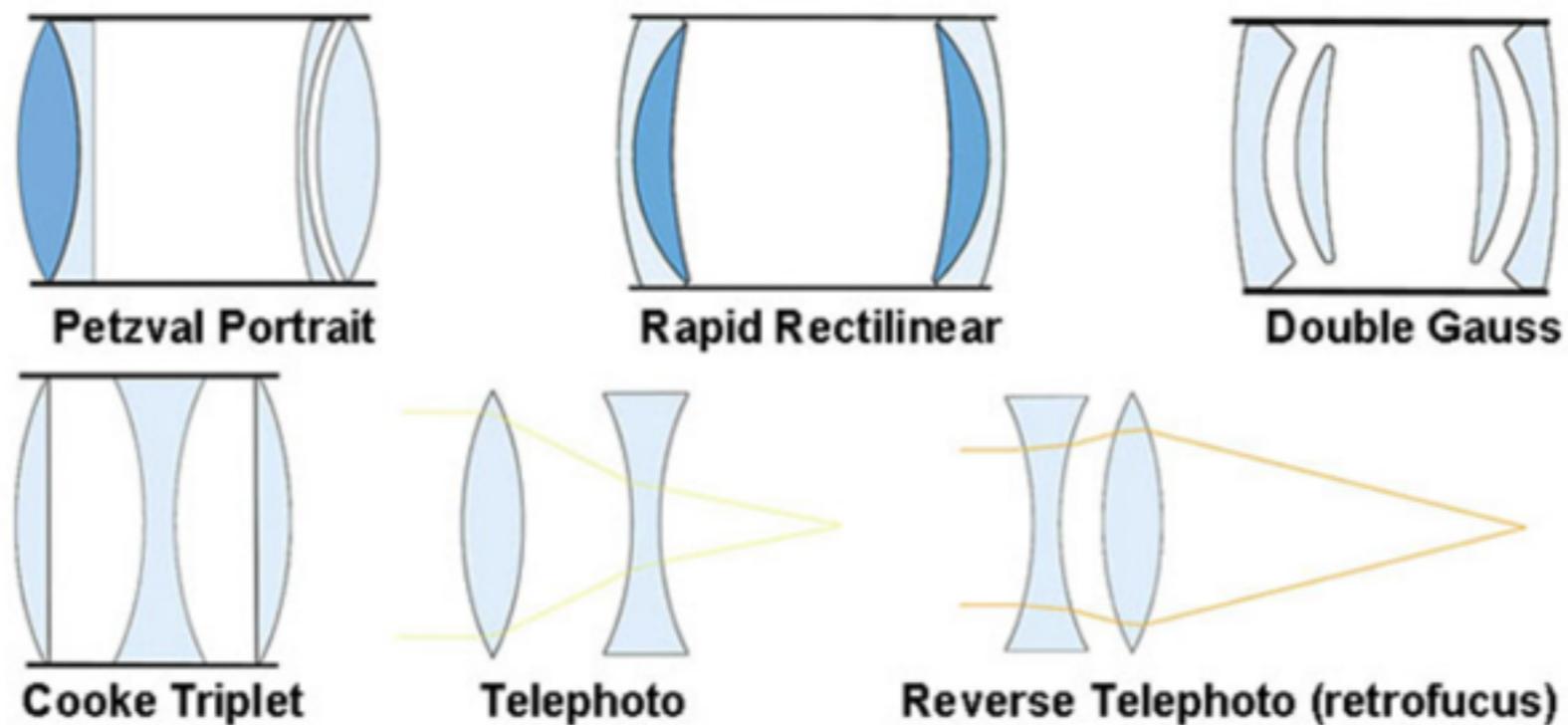
Vignetting - edges going darker (or lighter)







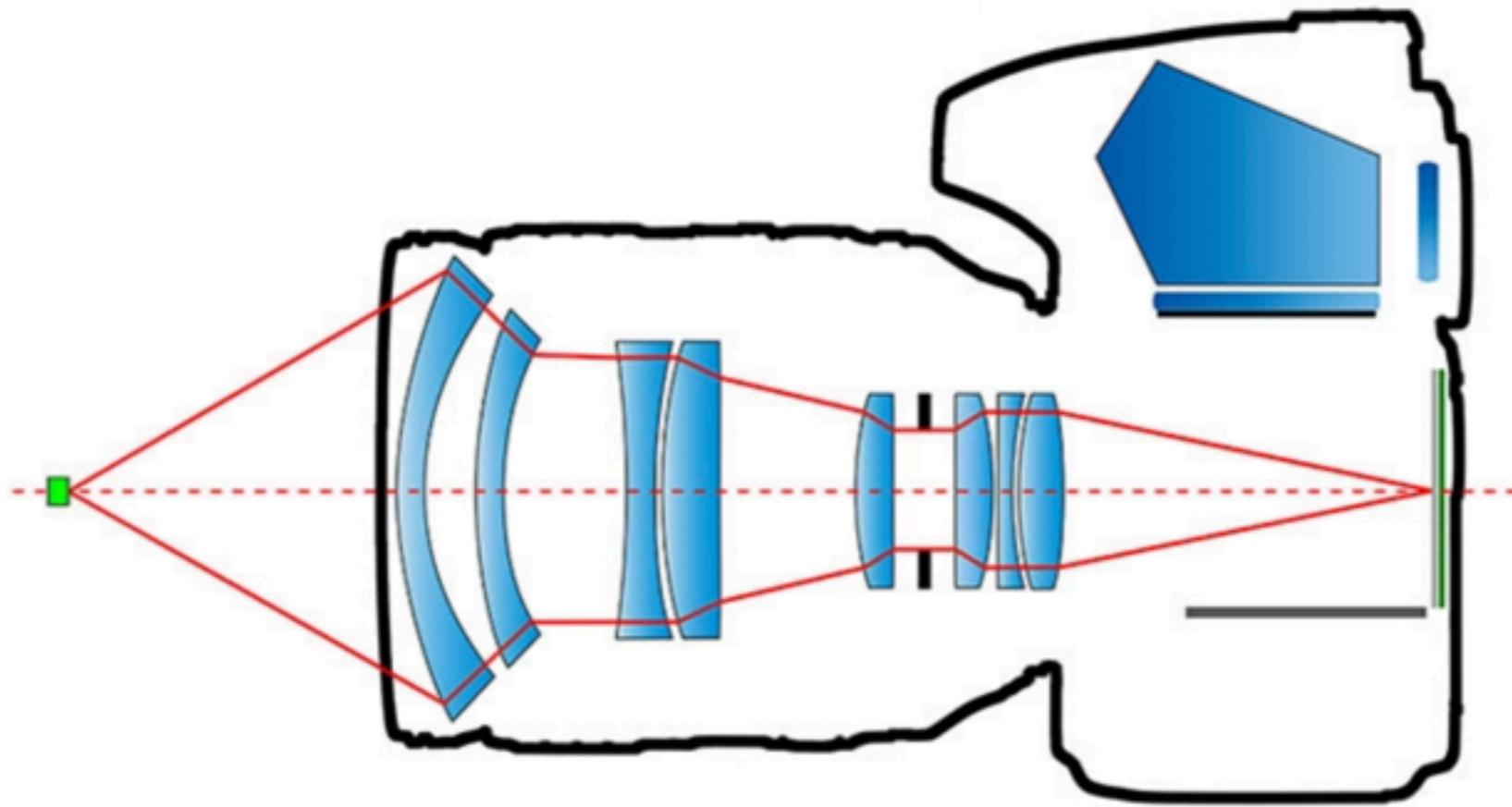
# Basic lens designs



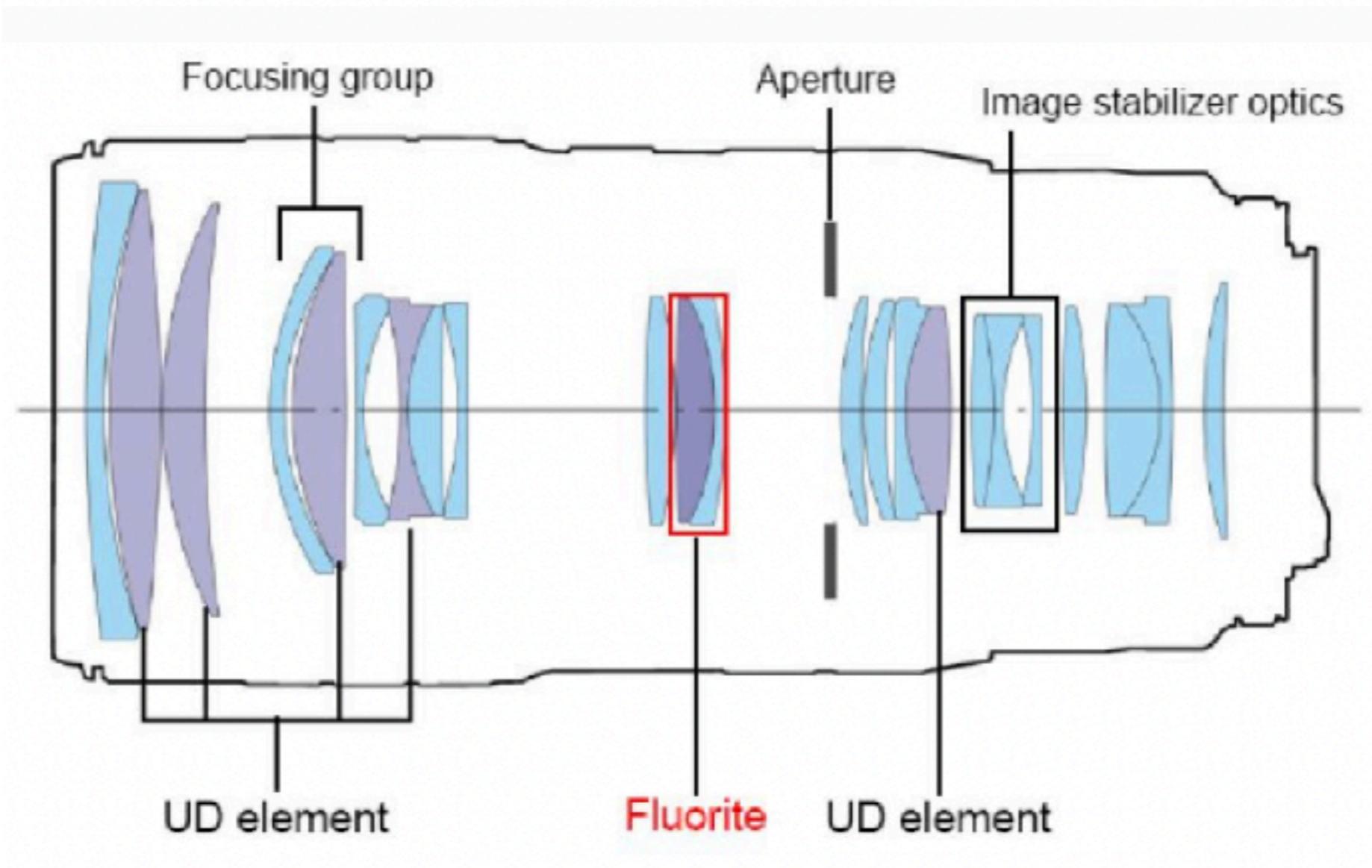
All glass has a refractive index - light bending...

This varies on its shape, constituents and its coatings

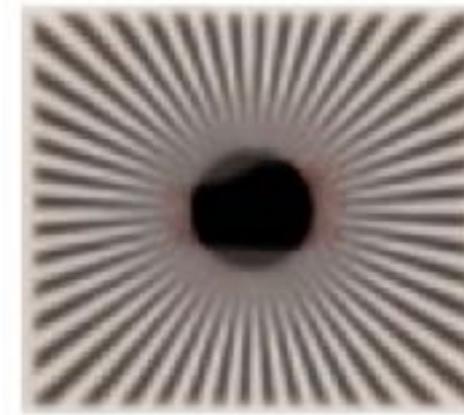
# Typical DSLR



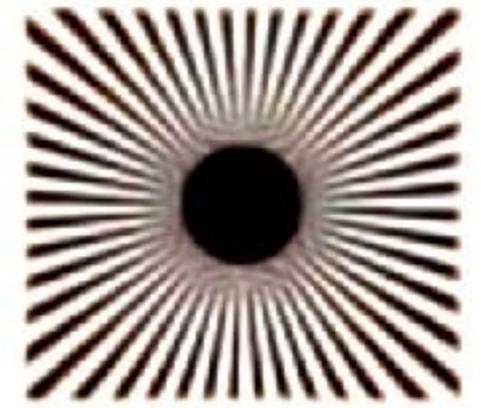
# Advanced lens design



# What is resolution?



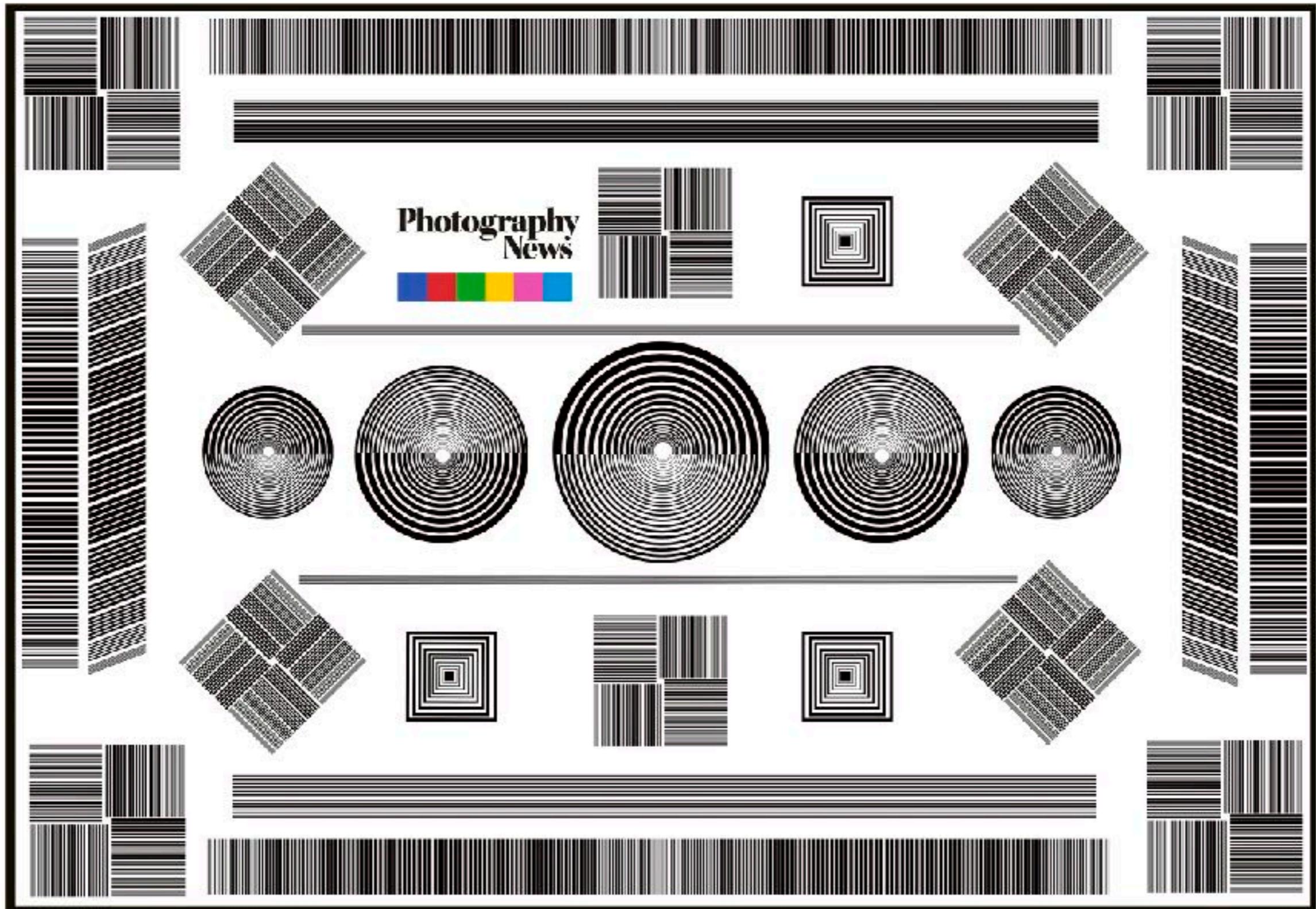
Lower Resolution



Higher Resolution



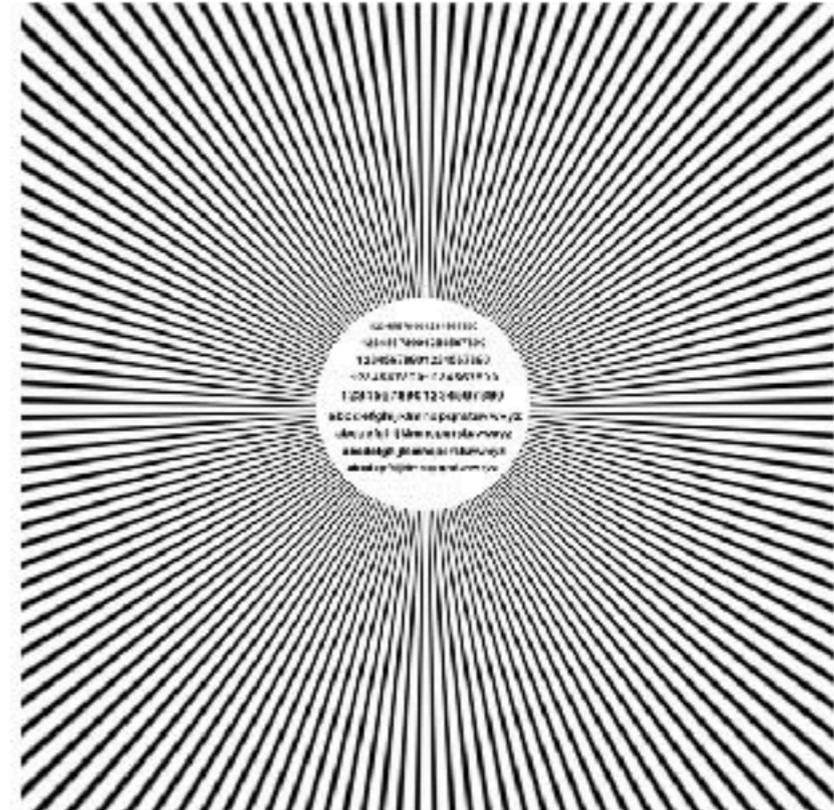
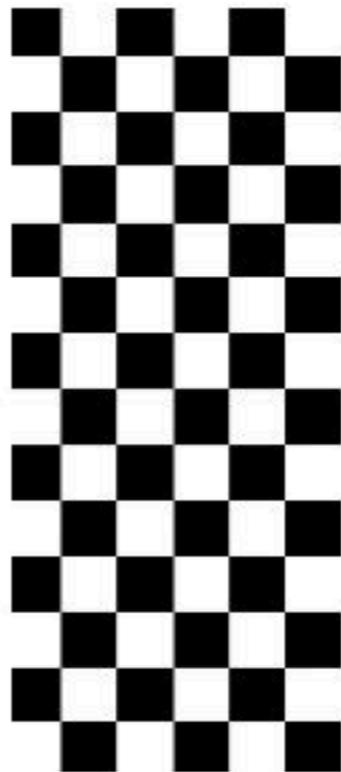
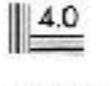
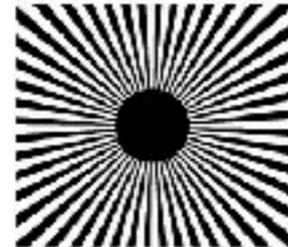
# Download and set up a test chart



# Print 2 copies off the test chart to a high standard

©2015 Bob Atkins <http://www.bobatkins.com/photography>

These test patterns are an approximation of the NBS 1010A Microscopy resolution test chart (ISO 3334 chart #2)



4 BLOCK OF TEXT  
4 BLOCK OF TEXT  
4 BLOCK OF TEXT  
4 BLOCK OF TEXT



100 mm



2.8

abcdefghijklmnopqrstuvwxyz1234567890



1.3 1.6 1.8 2.2 2.5 2.8 3.1

1234567890  
1234567890  
1234567890  
1234567890  
1234567890

# Set up a test chart

Find a square grid surface - peg board or a brick wall.

You will need even lighting - outside in daylight is perfect.

Fix camera to a tripod, use a cable release if you have one.

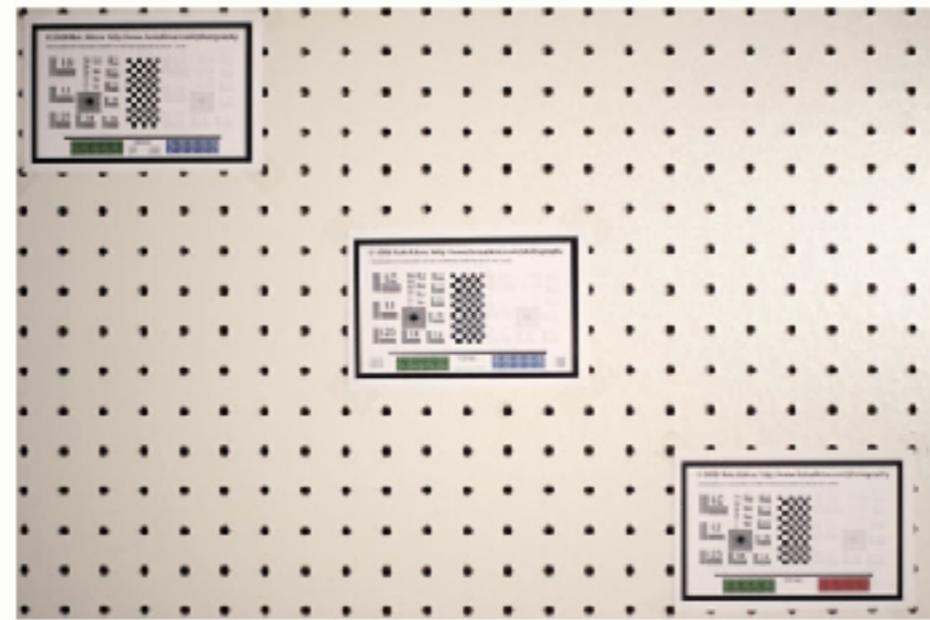
Frame up on 22" x 15" for APS-C and 36" x 24" for full frame.

Find the centre and be dead 90° to it, use a mirror to check.

Write post it notes of each aperture and lens focal length you will use.

Set camera to aperture priority. Use delay action and mirror lock?

Find normal exposure - so if using peg board set compensation to + 1.5



# Making and evaluating your exposures

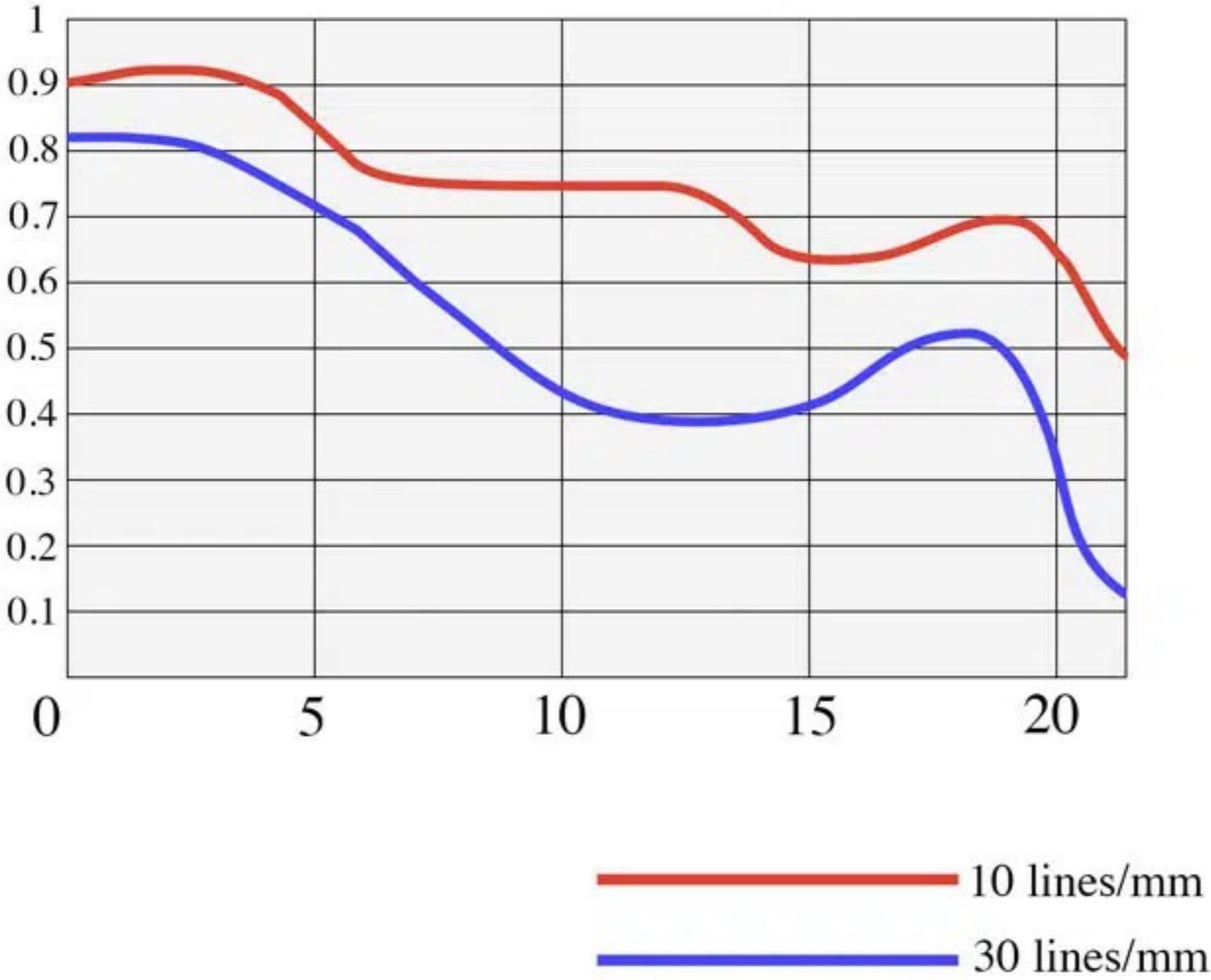
Start with open aperture and progressively go down 1 stop at a time.

By using aperture priority your exposures should stay the same.

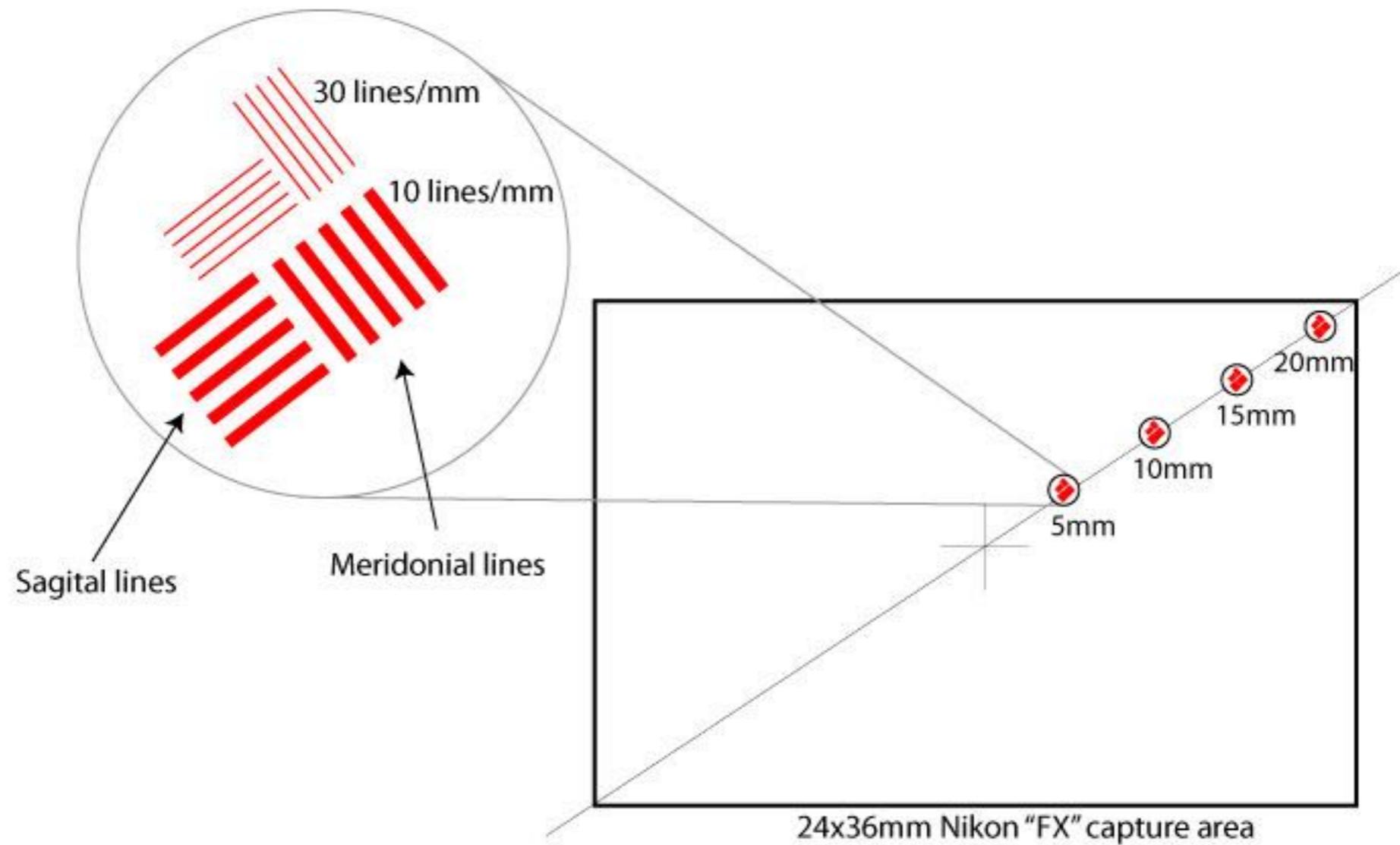
Evaluate on the computer - use the software you normally use as some will detect the lens info and apply corrections.

Note best aperture for sharpness in the centre and at the edge of lens

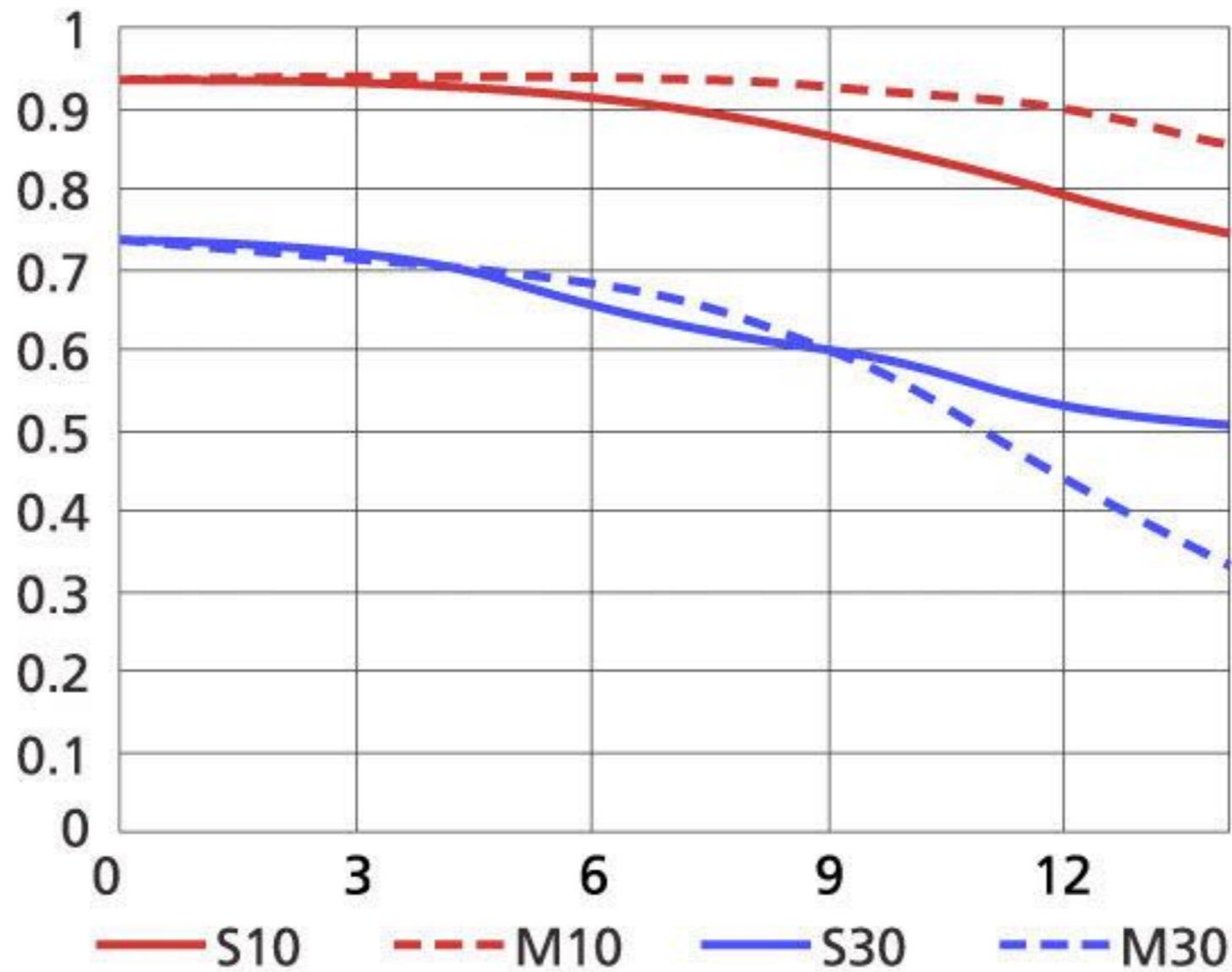
# MTF charts (Modulation Transfer Function)



# MTF charts - the test charts

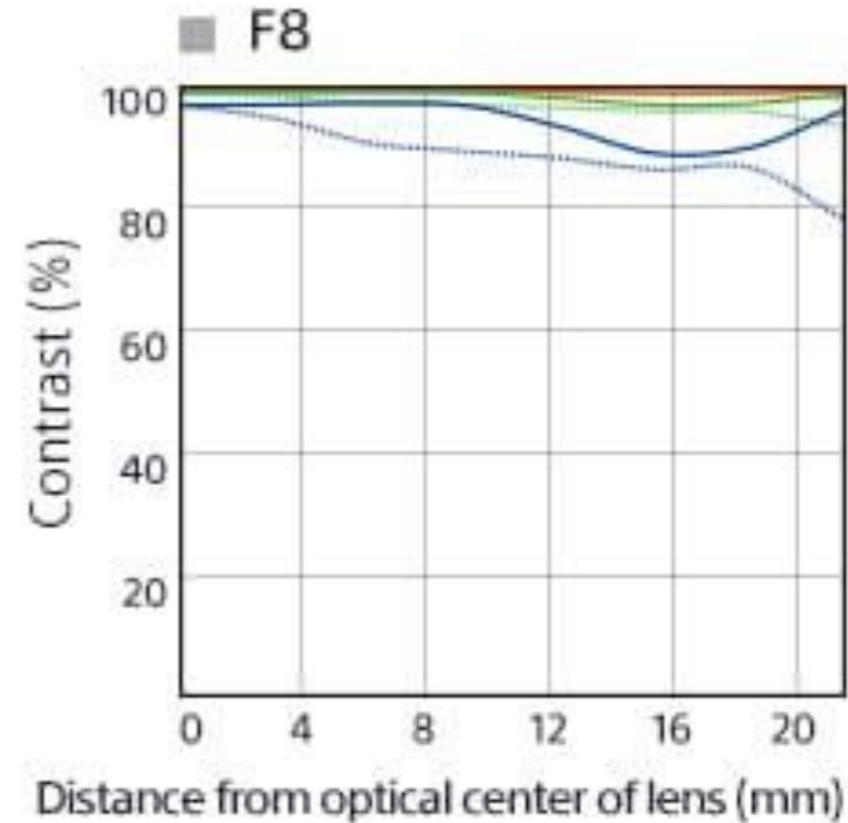
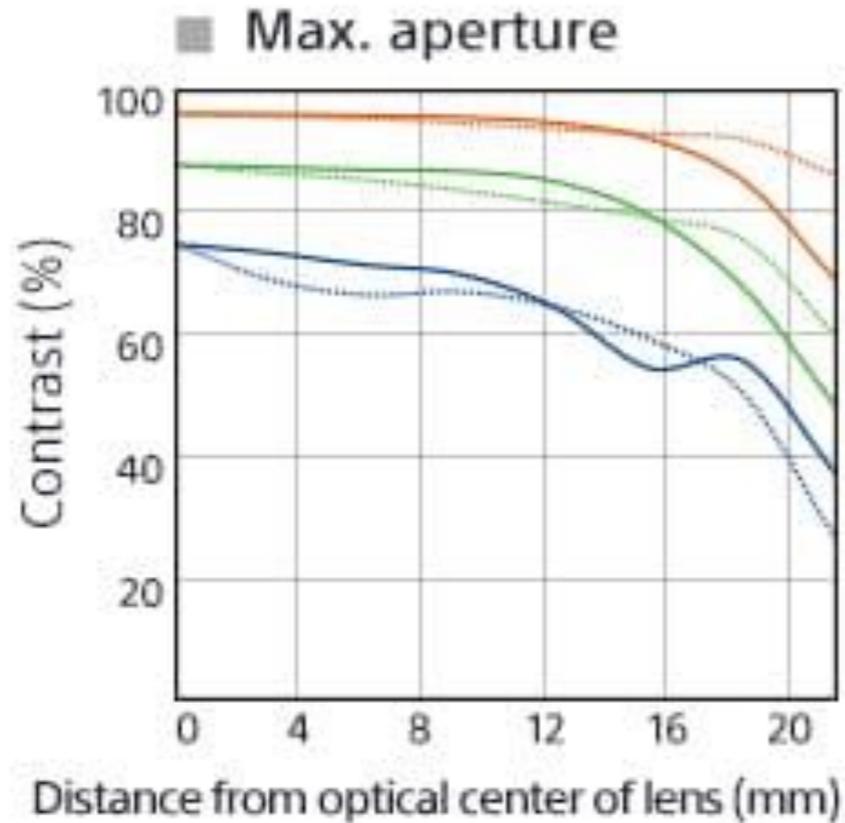


# MTF charts - understanding them



| Spatial Frequencies | S: Sagittal   | M: Meridional   |
|---------------------|---|---|
| 10 lines/mm         |  |  |
| 30 lines/mm         |  |  |

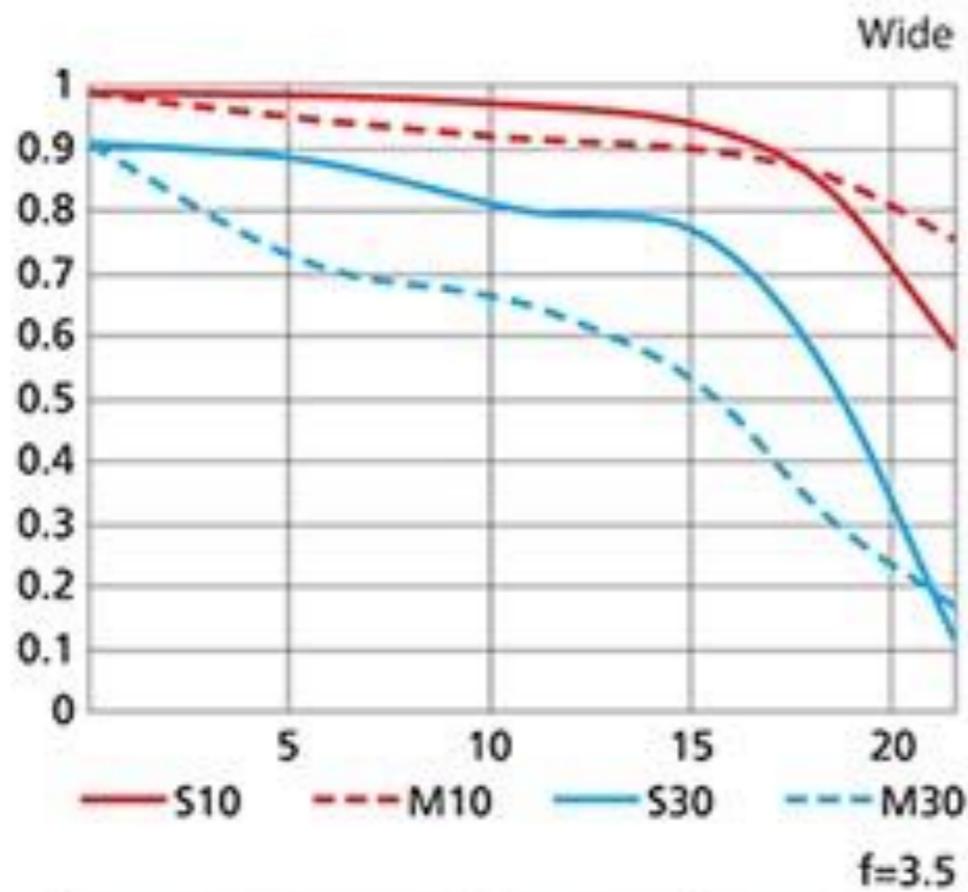
# MTF charts - affect of Aperture



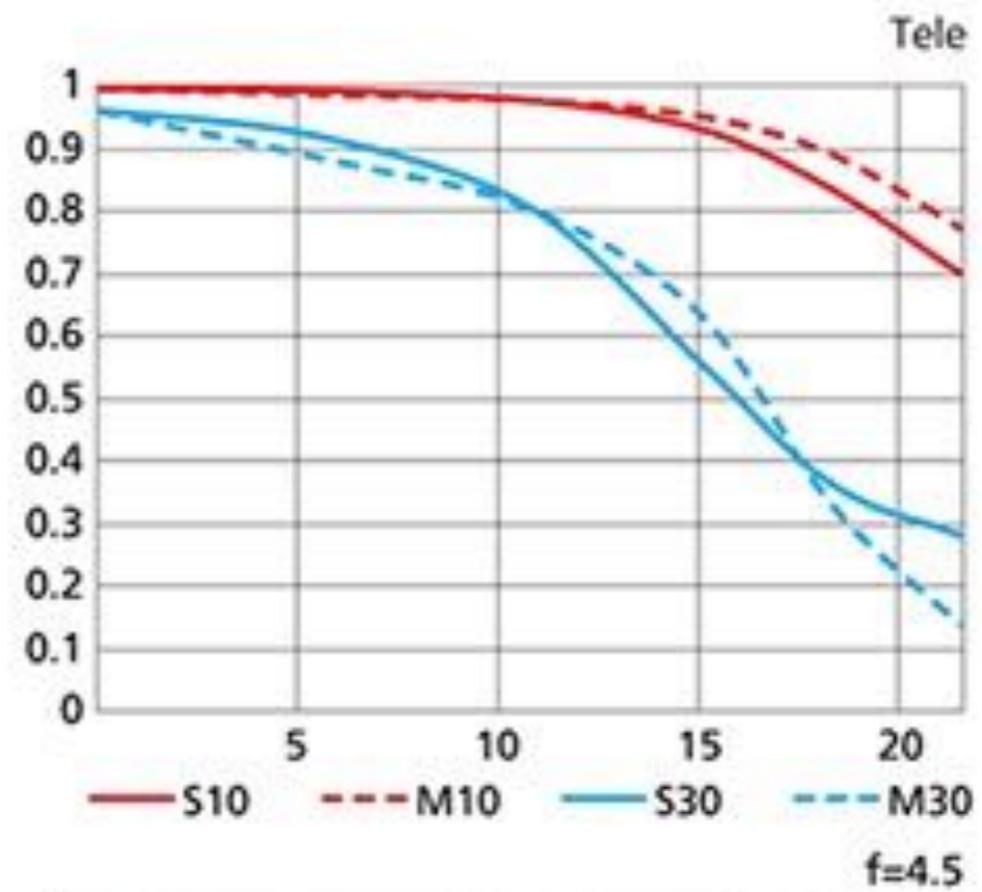
| Spatial frequency  | R | T     |
|--------------------|---|-------|
| 10 line pairs / mm | — | ..... |
| 20 line pairs / mm | — | ..... |
| 40 line pairs / mm | — | ..... |

R: Radial values T: Tangential values

# MTF charts - Zoom lenses

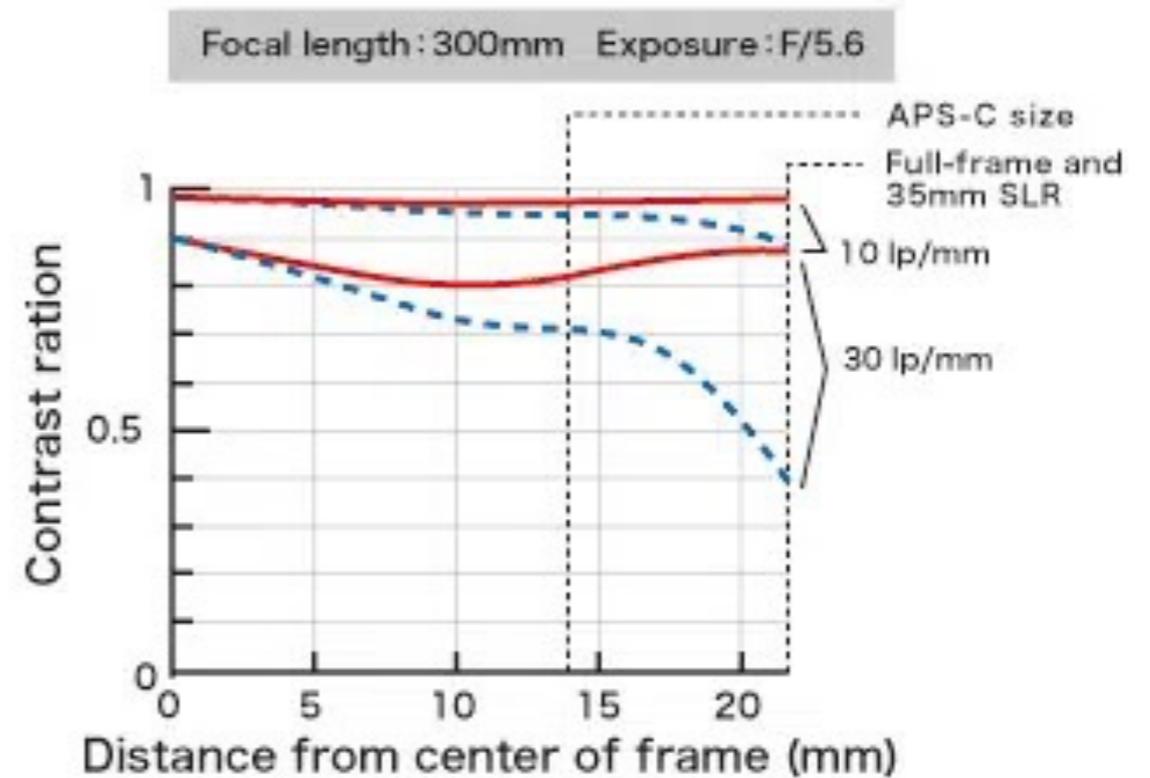
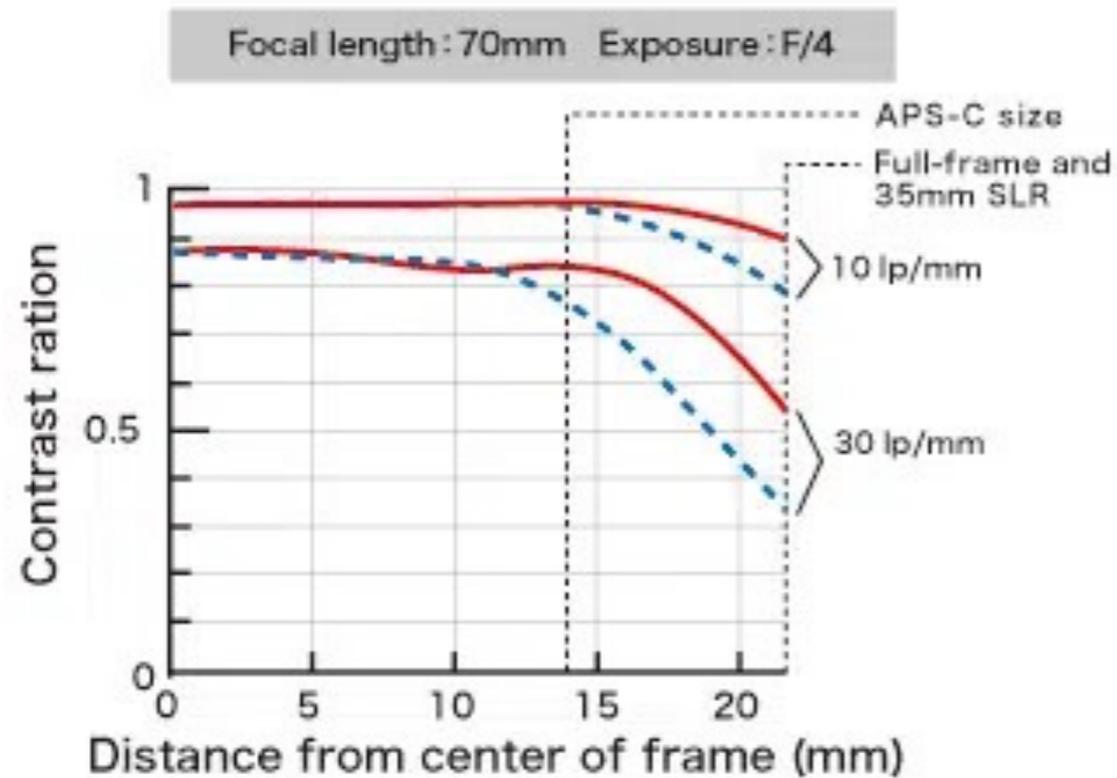


| Spatial Frequencies | S: Sagittal | M: Meridional |
|---------------------|-------------|---------------|
| 10 lines/mm         |             |               |
| 30 lines/mm         |             |               |



| Spatial Frequencies | S: Sagittal | M: Meridional |
|---------------------|-------------|---------------|
| 10 lines/mm         |             |               |
| 30 lines/mm         |             |               |

# MTF charts - APS-C Full Frame comparison



|          | Radial direction | Circumferential direction |
|----------|------------------|---------------------------|
| 10 lp/mm |                  |                           |
| 30 lp/mm |                  |                           |