Making a projector

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Goals of project

- Learning lens equation
- Making single lens projector
- Making double lens projector
- Find magnification

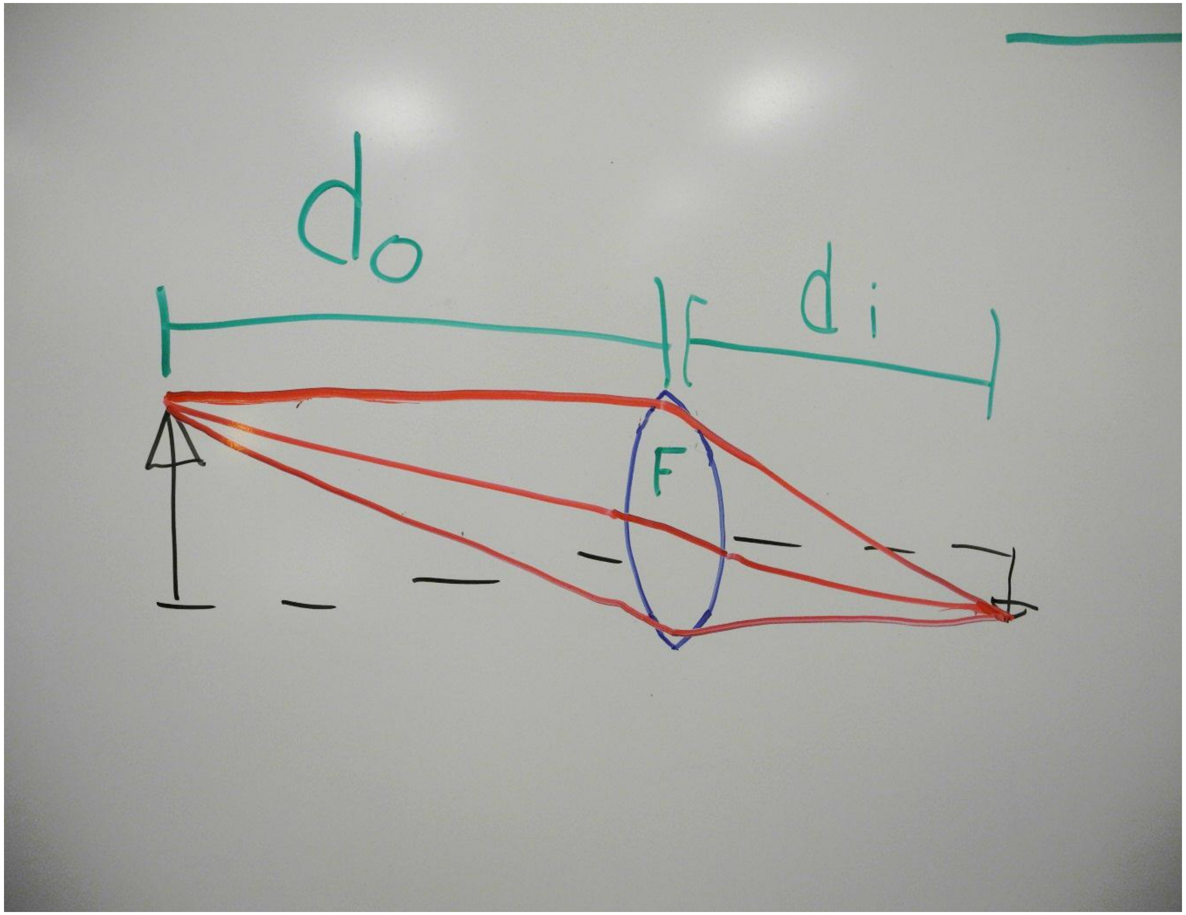
why

Lens Equation

$$1/d_o + 1/d_i = 1/f$$

- Used to set up an imaging system
- Finding focal distance in a lens
- magnification

Forming image diagram



Using lens equation

Image-----------30cm----------lens------20cm-----------object
image distance   object distance

$$1/20cm + 1/30cm = 1/f$$

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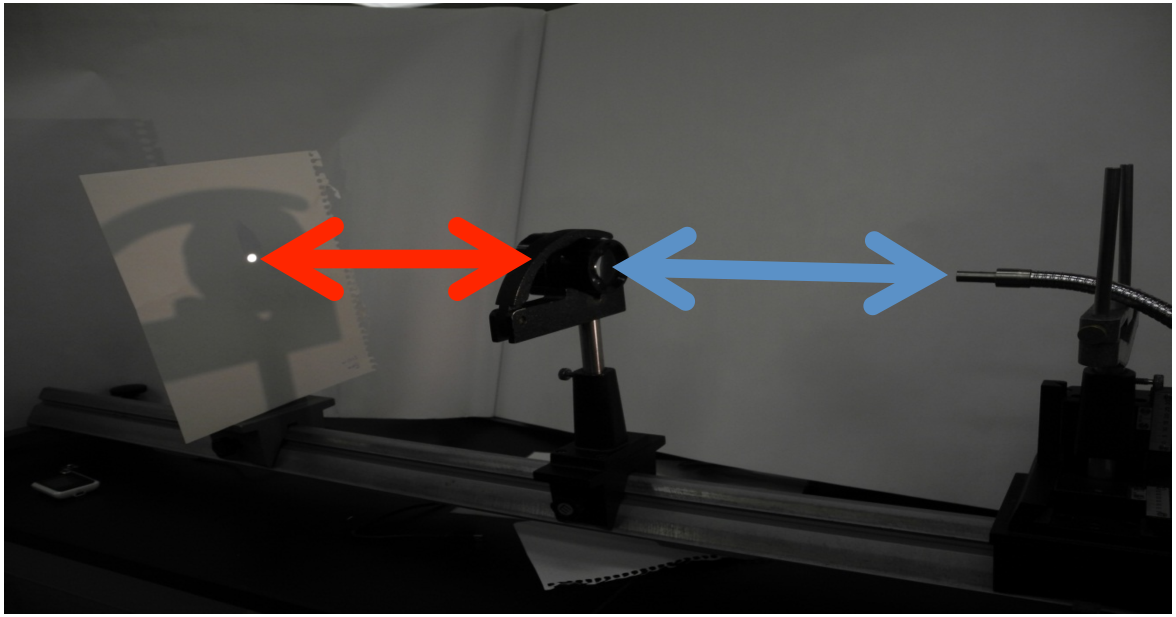
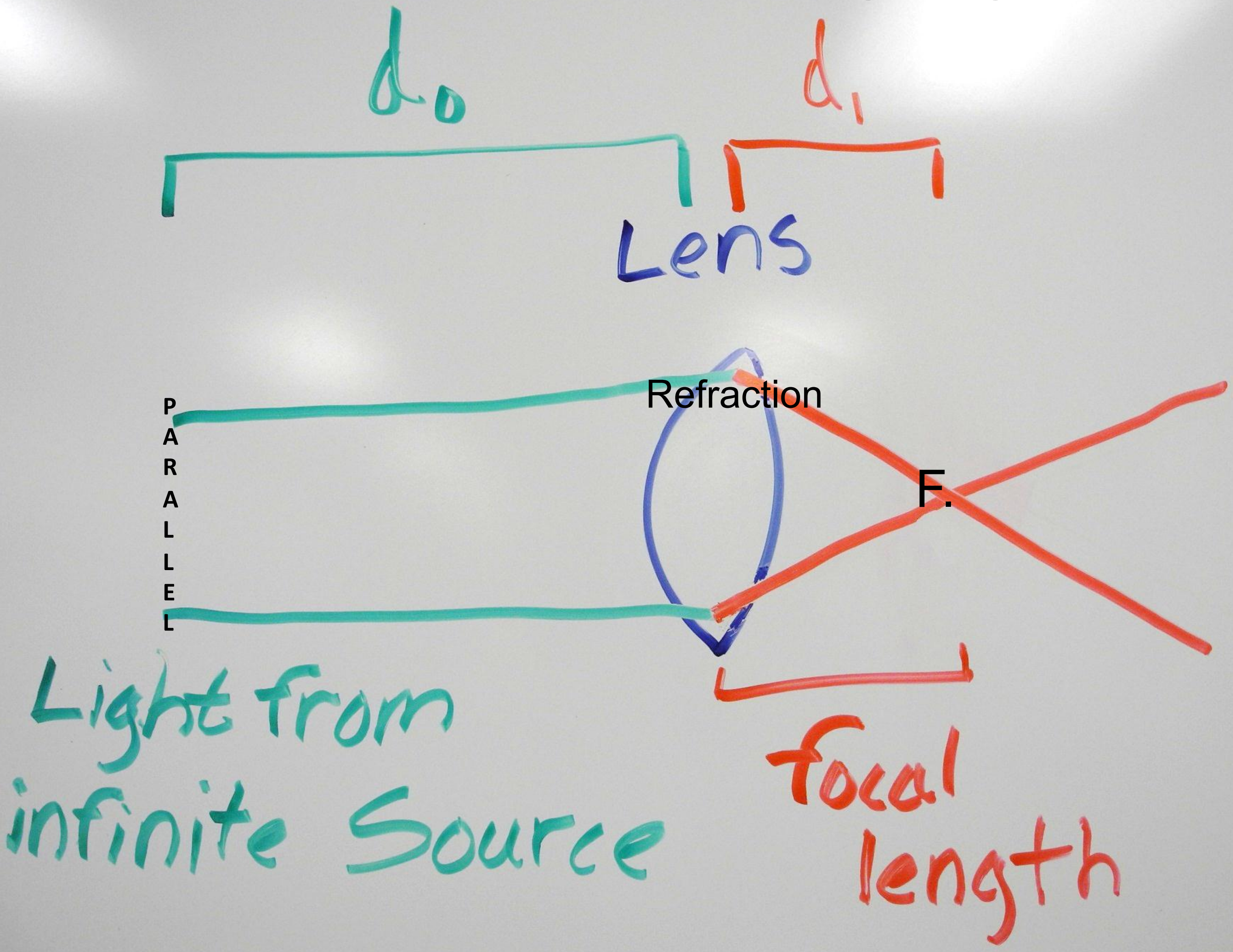


∞ Source Imaging



The Thin Lens Equation

When Plugging in for ∞

$$\frac{1}{f} = \frac{1}{d_0} + \frac{1}{d_1}$$

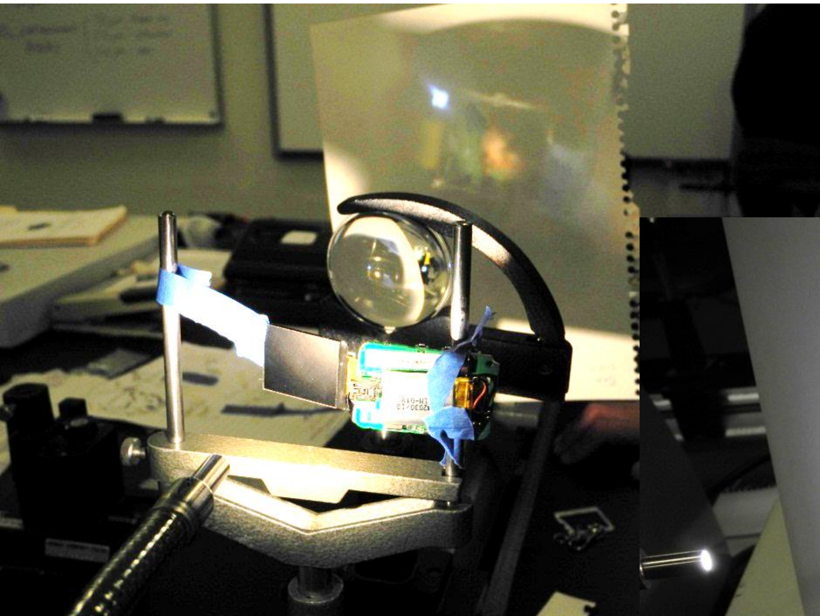
$$\frac{1}{f} = \frac{1}{\infty} + \frac{1}{d_1}$$

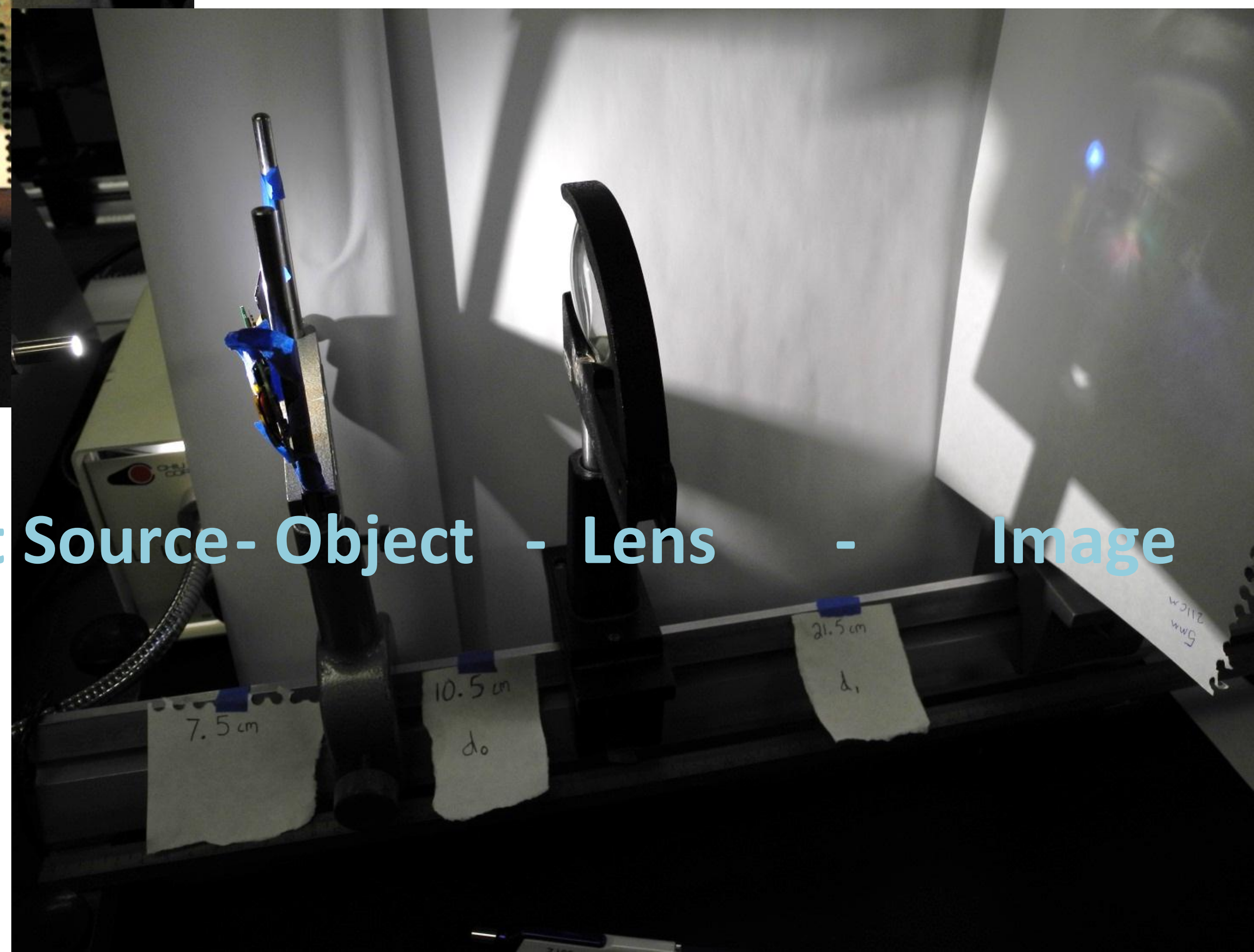
$$f = 0 + d_1$$

$$f = d_1$$

focal length = distance of

Single Lens (Diffuse) Imaging

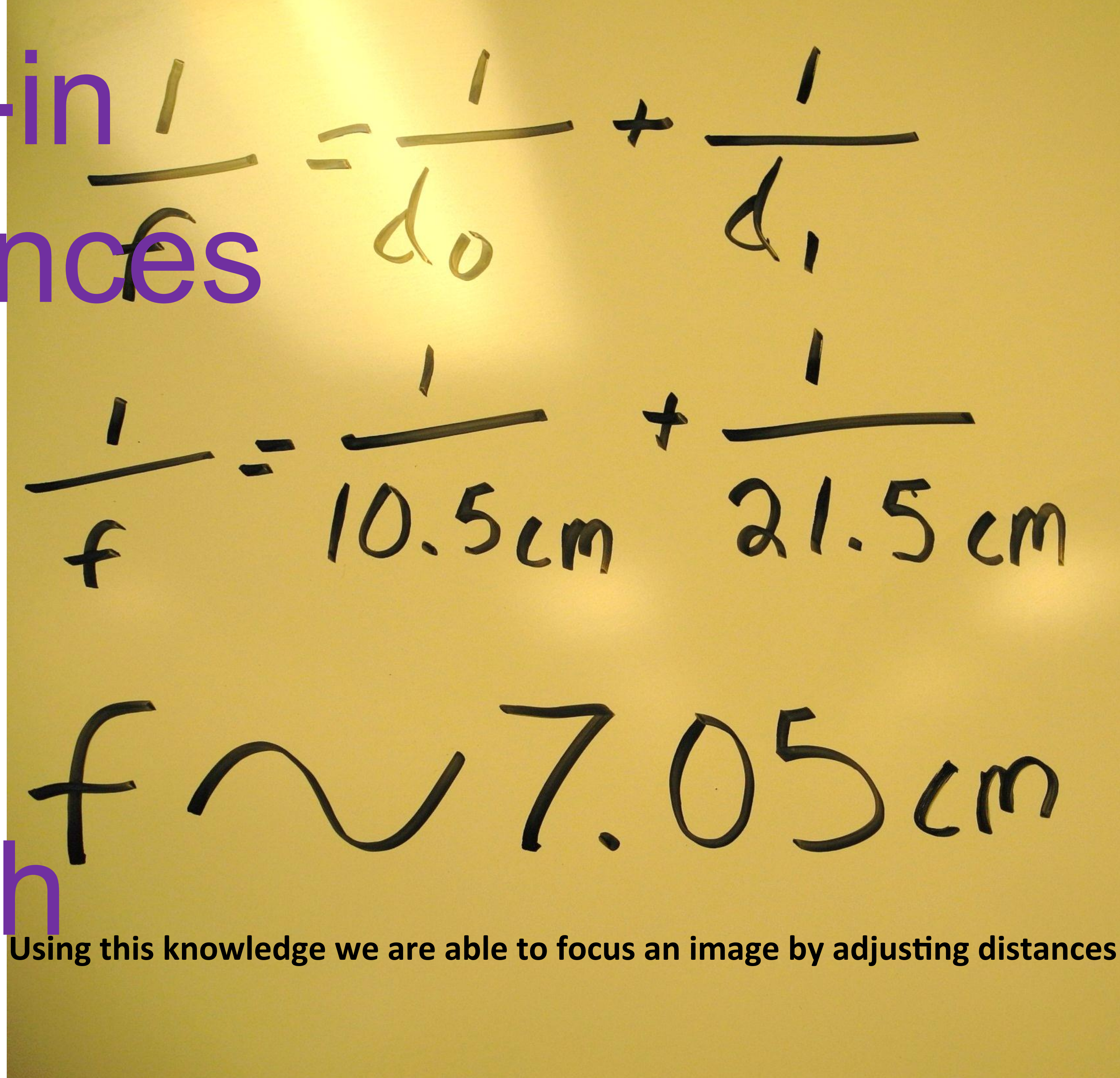




Light Source- Object - Lens - Image

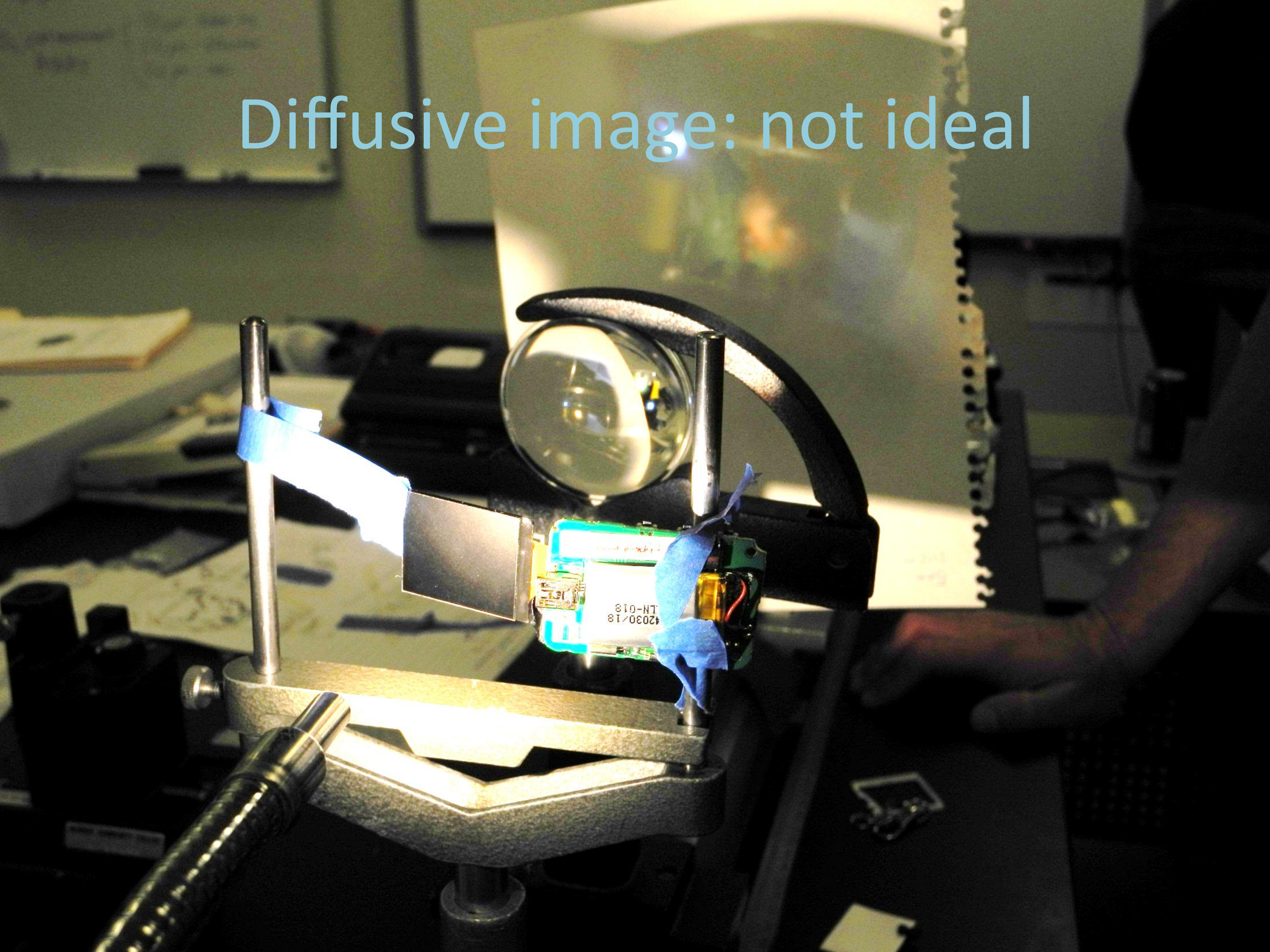
do = 10.5cm
di = 21.5cm

Plug-in distances to find focal length



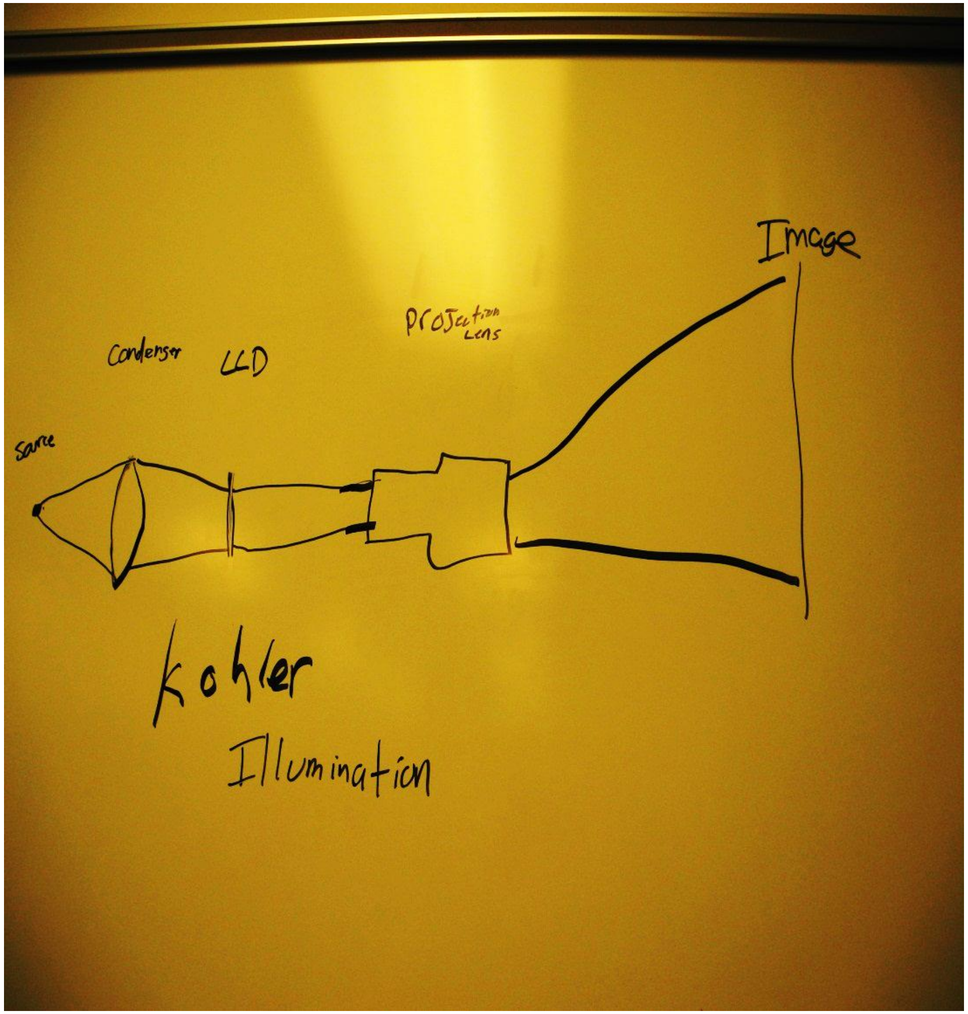
Using this knowledge we are able to focus an image by adjusting distances

Diffusive image: not ideal



Kohler imaging

This process is used to make a bright but extremely large image or highly magnified image. (ex. Projector, Microscope, ect.)

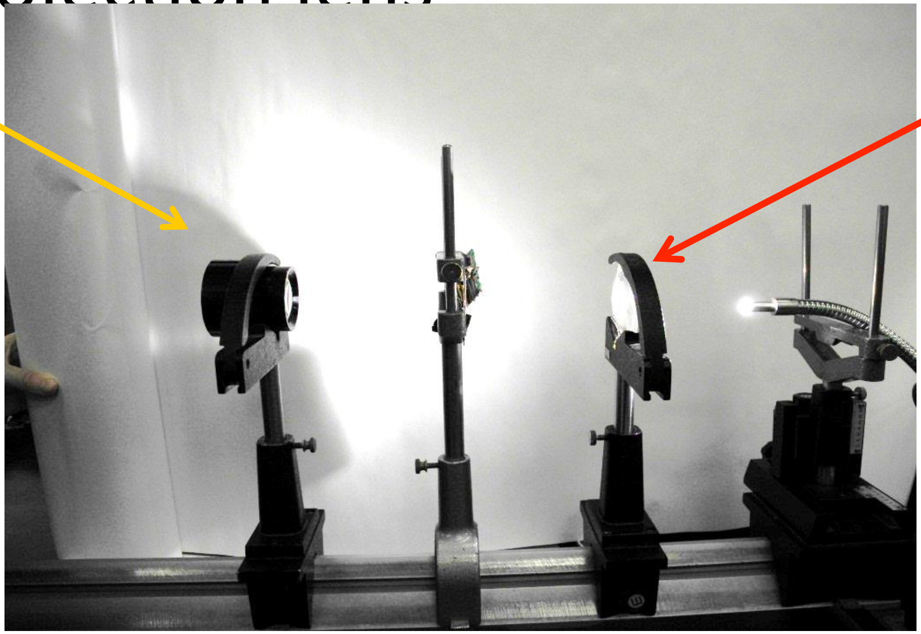


Condenser lens

- The condenser lens images the source onto the projection lens

This is the projection lens

This is the condenser



www.thorlabs.com

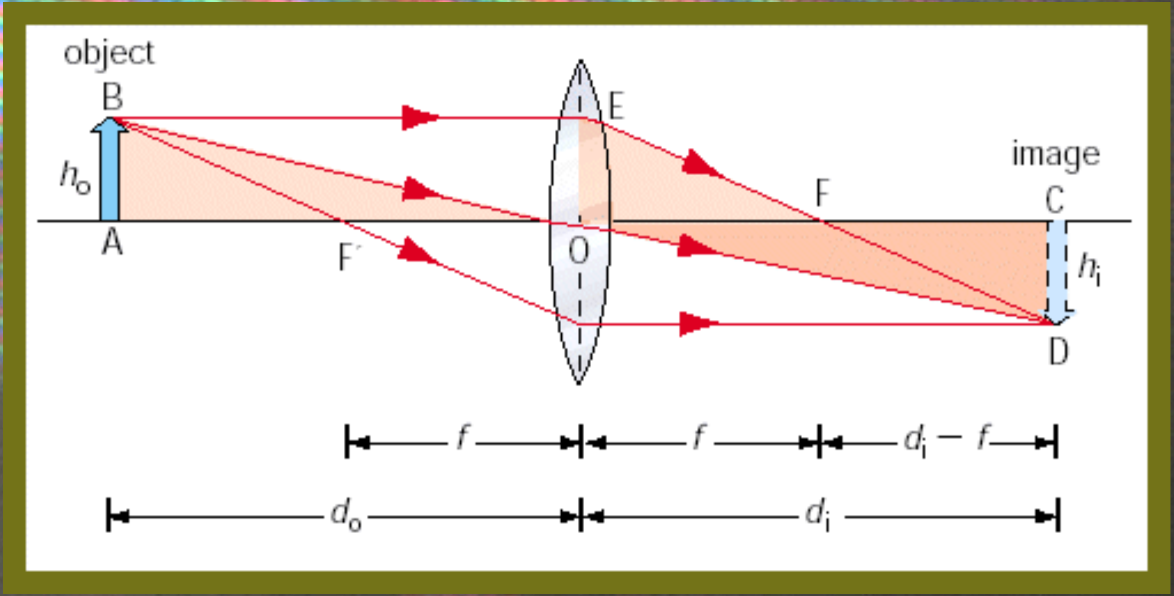
Projection lens

- The projection lens takes the image of the LCD and projects the image onto the screen

This is an example of a projection lens

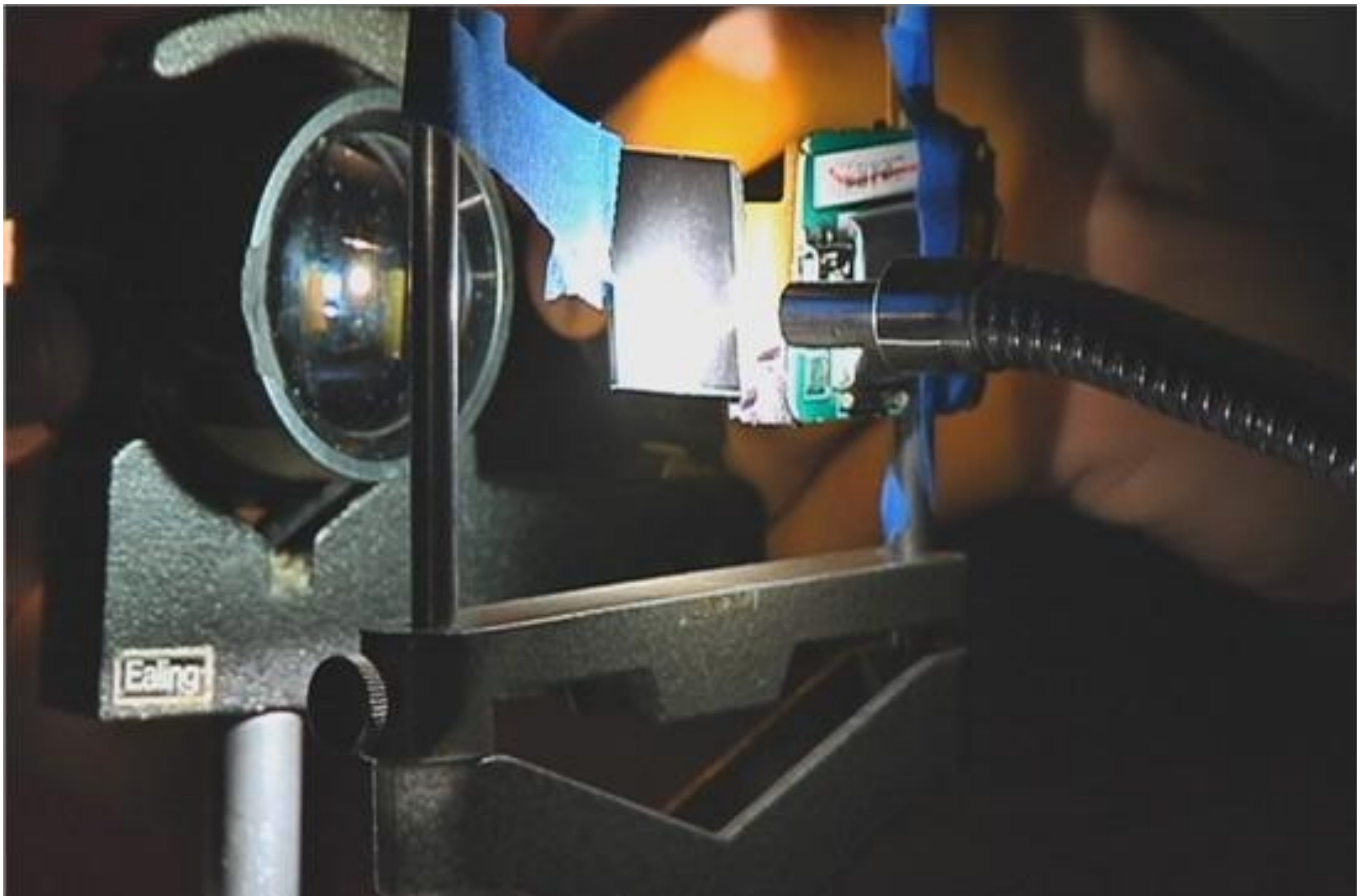
Magnification

- M=hi/ho creates ***similar triangles*** also creates a ratio of sizes that equals magnification (30cm:300cm= 30x)



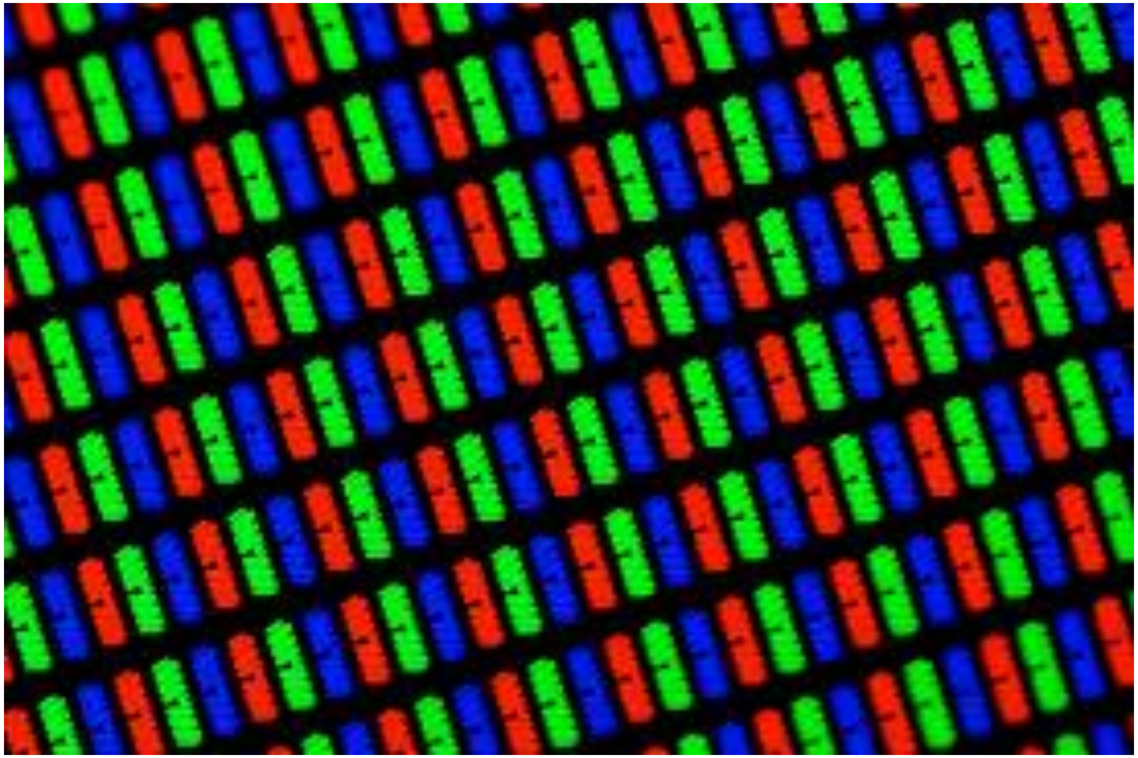
Liquid Crystal Display Keychain

Liquid Crystal Display

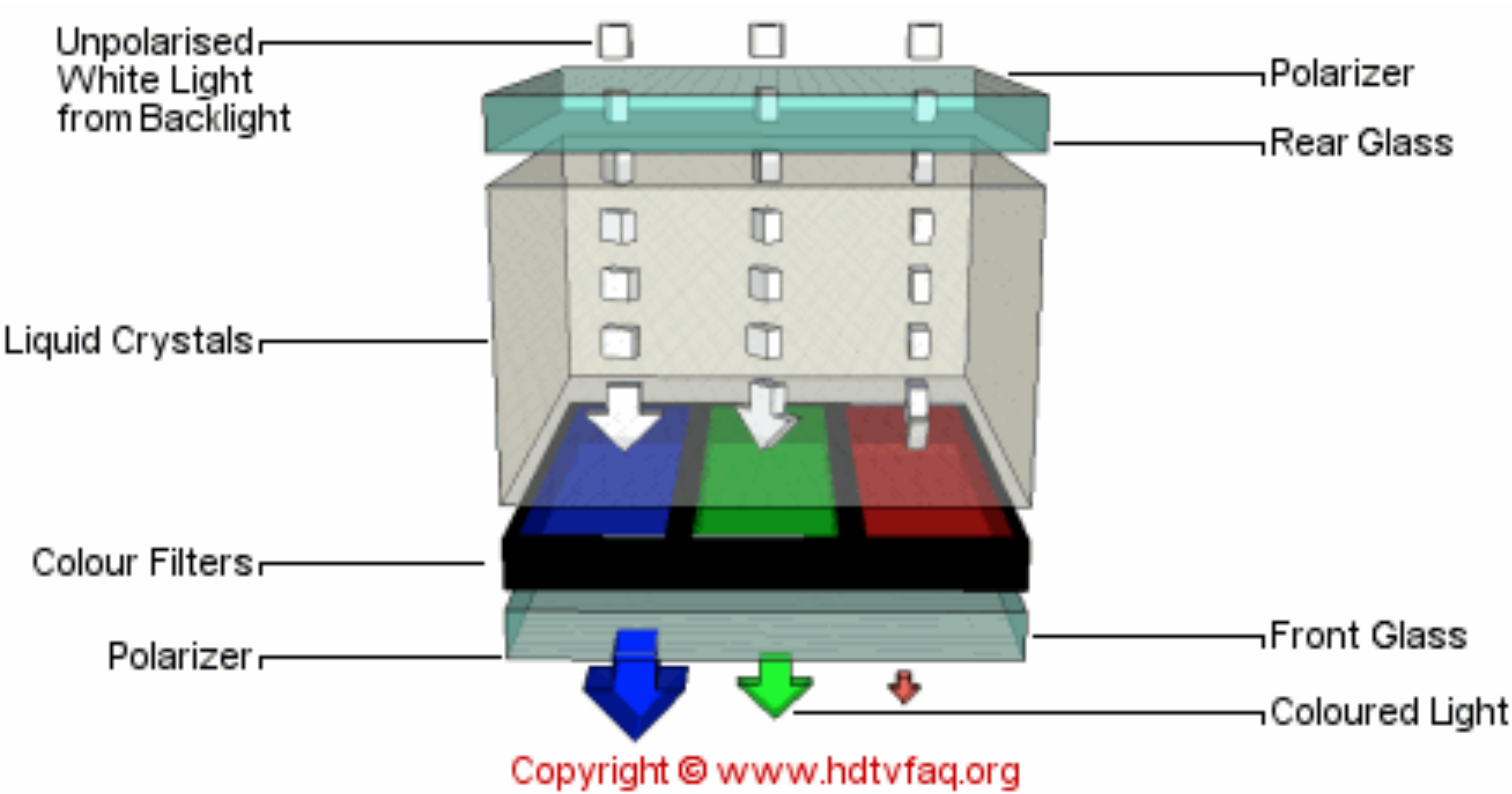


How LCDs Work

- Control brightness of each pixel
- Use polarization



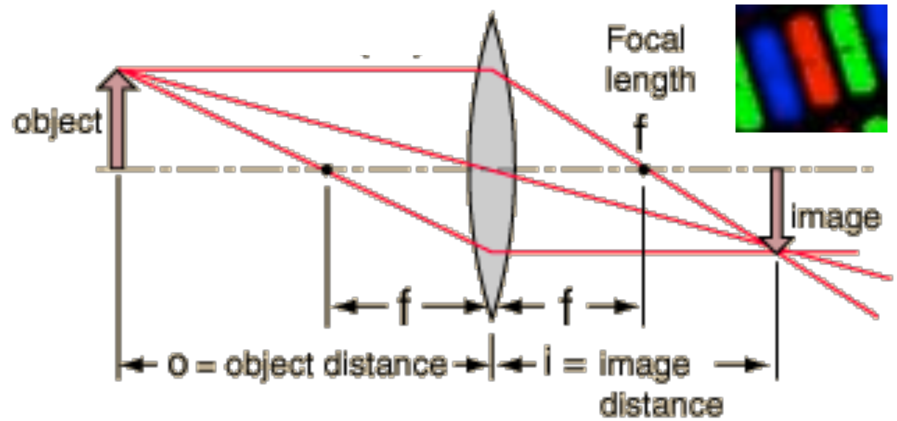
How LCDs Work



Measuring Pixel Size

- Kohler imaging & magnification

  130 µm



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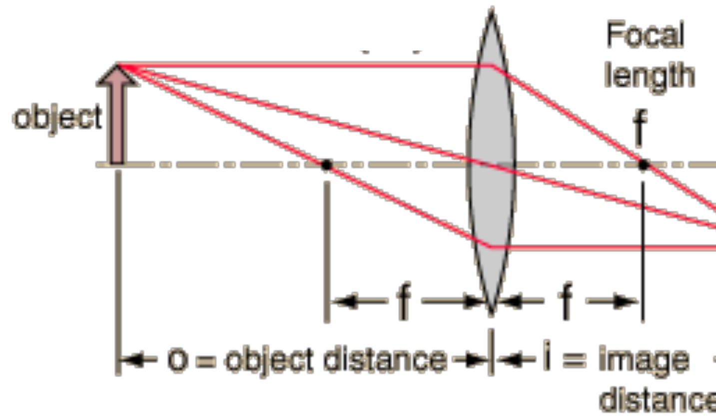

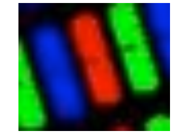

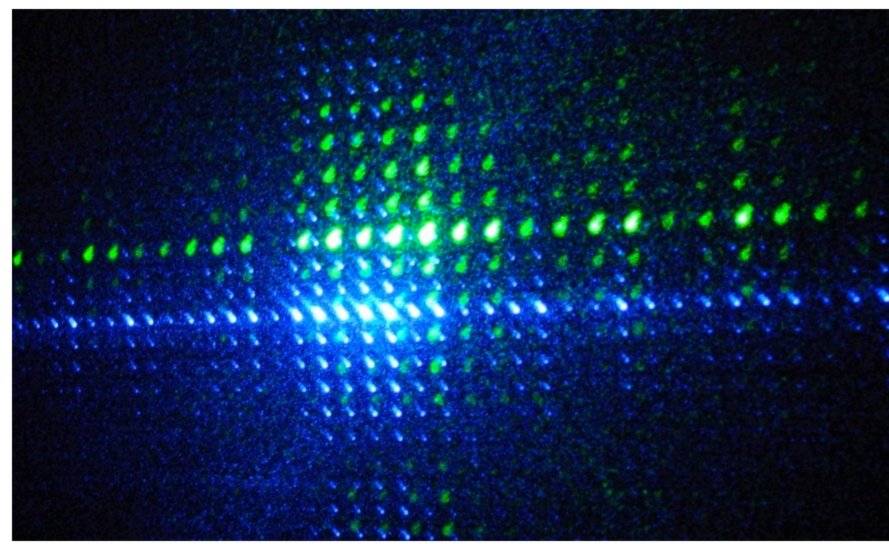

- Diffraction with laser

  210 µm

- Calculation from LCD keychain manual

  202 µm

Conclusion

- The lens equation is used to find where the image will be formed ($1/f=1/d_i+1/d_o$)
- methods to find the focal length $1/f=1/d_i+1/d_o$
- Diffusive imaging was not very bright
- Kohler imaging was the best quality and high magnification
- We were able to measure the pixel size of the LCD