Hi John,

How big an enlargement and still appear sharp eh? That can be quite (unnecessarily) complicated, but there is a relatively "simple" method of doing this. Here come some more symbols :-)

Diffraction limits the smallest separation Δ_{fc} of two points of light (produced by a circular aperture) at the film/chip plane that are just barely resolved to

$$\Delta_{fc} = \frac{1.22\lambda F_C}{D} = 1.22\lambda N$$

where λ is the wavelength of light and N is the usual f/number. Using an average wavelength of (yellow-green) light as 550 x 10^{-6} mm, yields

$$\Delta_{fc}(\mathrm{mm}) = \frac{N}{1490}$$

Depending on the value of N, this can be larger than the resolution of the film or chip. Insofar as enlargements are concerned, you need to use the LARGER of the two. For example, if a chip has a pixel size of 0.01mm and you plan to use f/22, then Δ_{fc} = 22/1490 = 0.015mm. In this case the larger of the two is due to diffraction, and therefore Δ_{fc} should be set to 0.015mm. On the other hand, if you were using f/11, then Δ_{fc} = 11/1490 = 0.007mm. The larger of the two this time is the pixel size and so, here, Δ_{fc} should be set to 0.01mm. Naturally these equations are based on "ideal" optics.

After an enlargement by a factor E, the smallest resolvable detail are now separated by a distance $E\Delta_{fc}$ and this needs to be smaller than the human eye can see at your chosen viewing distance D_V.

The angular resolution of a "sharp" human eye is about 1/2000 of a radian. At a viewing distance D_V this corresponds to seeing points only D_V/2000 mm apart. Therefore, in order for an enlarged image to appear sharp,

$$E\Delta_{fc} \le \frac{D_V}{2000}$$

In other words, the enlargement needs to satisfy the condition

$$E \le \frac{D_V}{2000\Delta_{fc}}$$

If you were employing f/22, and Δ_{fc} is 0.015mm and if your intended viewing distance is 400mm, then the maximum enlargement is E = 13X.

If you selected f/numbers which ensured that Δ_{fc} is always the pixel size (0.01mm), then your maximum possible enlargement is

$$E_{max} = \frac{D_V}{20}$$

For a viewing distance of 400mm, this corresponds to E_{max} = 20X.

Hope this helps :-)
Cheers,
Frank