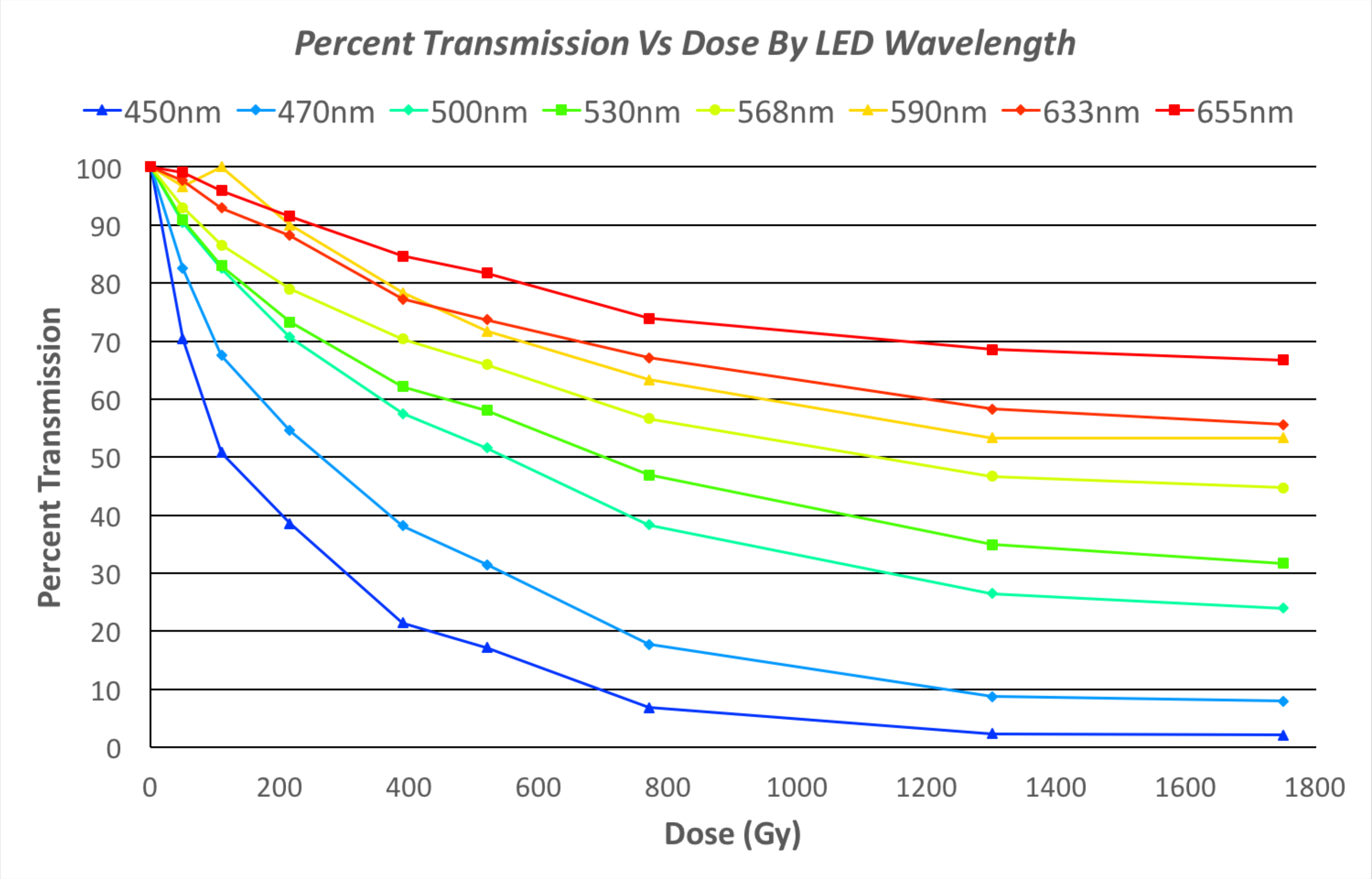
Fiber Irradiation – Decay Constant

Rayleigh Scattering:

- Elastic scattering of light by particles smaller than λ
- The scattering intensity $\mathrm{I} \propto \lambda^{-4}$
- We predict irradiation causes local damage in the fiber glass. The light scatters off of these impurities, leading to Rayleigh scattering
- We predict the fiber transmission will decay as $e^{-\frac{\alpha}{\lambda^4}}$, where α is the decay constant

Transmissions Decay Curves by Wavelength



We calculate the decay constant α for each decay curve on the graph at left. We expect an exponential decay resembling $e^{-\frac{\alpha}{\lambda^4}}$ for each curve, and solve for α.

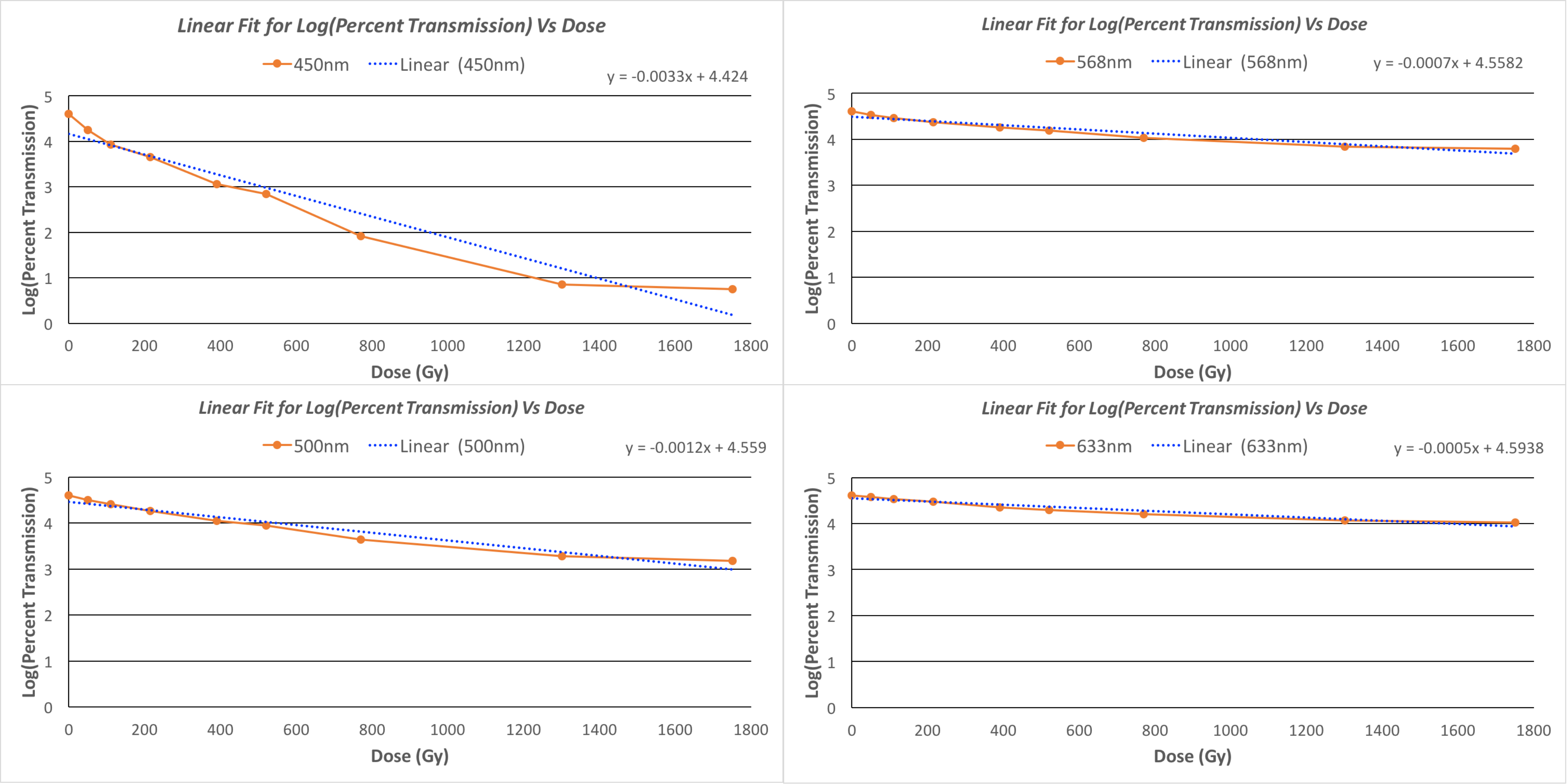
Procedure:

- For a given wavelength, we take the natural log of each data point
- We apply a linear fit to these points
- We take the slope of this linear fit and multiply by -λ^4 to acquire α

Our injectors use 655nm wavelength light. This wavelength displayed the minimum transmission decay among the 8 tested wavelengths.

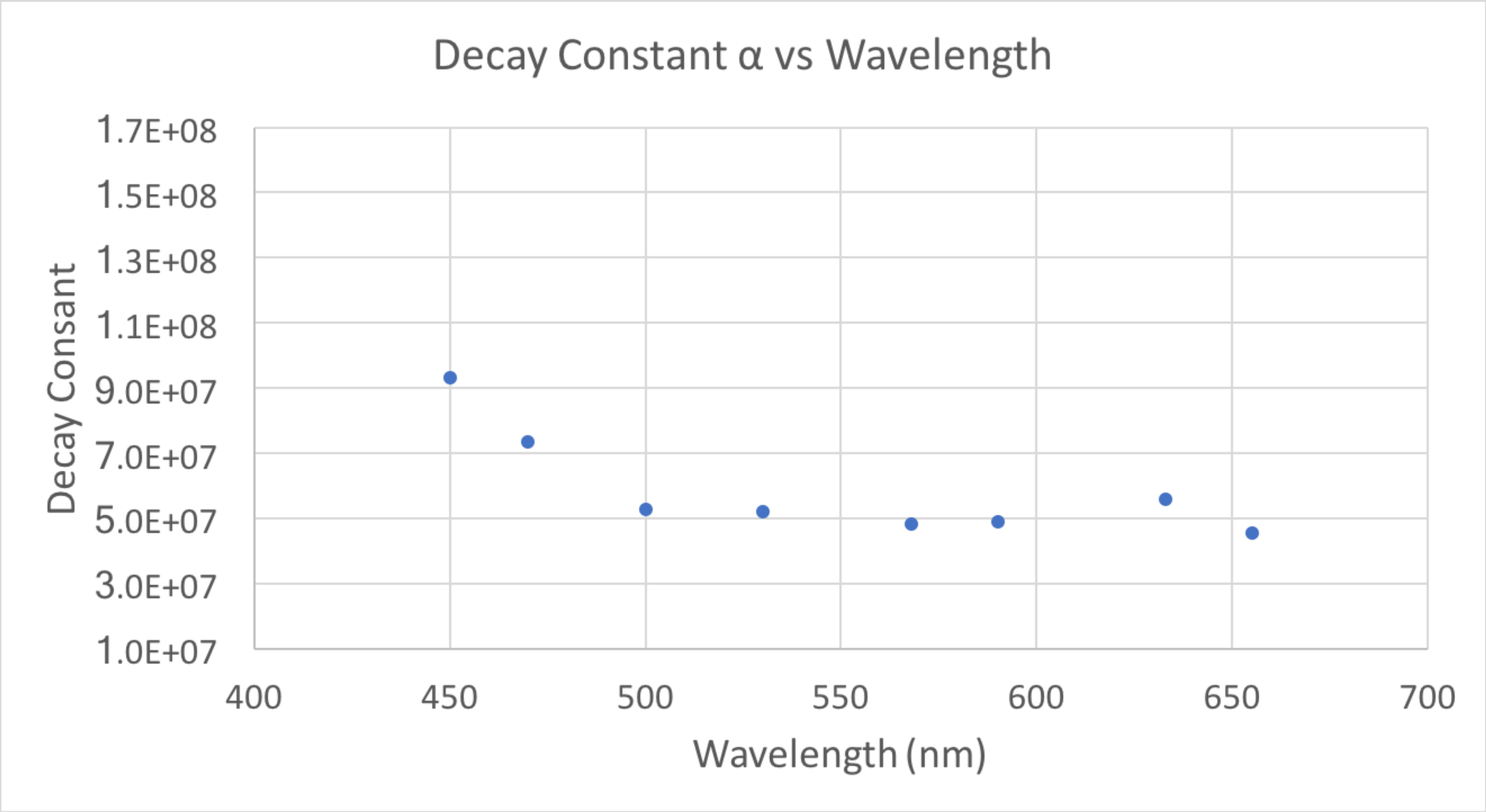
Linear Fits

We take the natural log of every point in each data set and plot against a linear fit. The slope is $-\frac{\alpha}{\lambda^4}$. The following plots show this procedure on a sample of four of the eight LED wavelengths we have to study.



Calculated Decay Constants by Wavelength

Wavelength (nm)	Decay Constant
450	1.3E+08
470	1.1E+08
500	7.6E+07
530	7.5E+07
568	7.4E+07
590	7.7E+07
633	8.3E+07
655	7.4E+07



Transmission Decay Cutoffs

We suspected that for the wavelengths whose transmission had decayed by 80%+, other wavelengths in the LED light may have been transmitting. We did two recalculations of the decay constants for the 450nm and 470nm wavelength LEDs by using only data above 80% and 90% transmission loss. We found the following:

Wavelength (nm)	Decay Constant (90% Cutoff)
450	1.3E+08
470	1.0E+08

Wavelength (nm)	Decay Constant (80% Cutoff)
450	1.5E+08
470	1.1E+08