REDUCTION OF PROTECTION FROM LASER EYEWEAR WITH ULTRASHORT EXPOSURE

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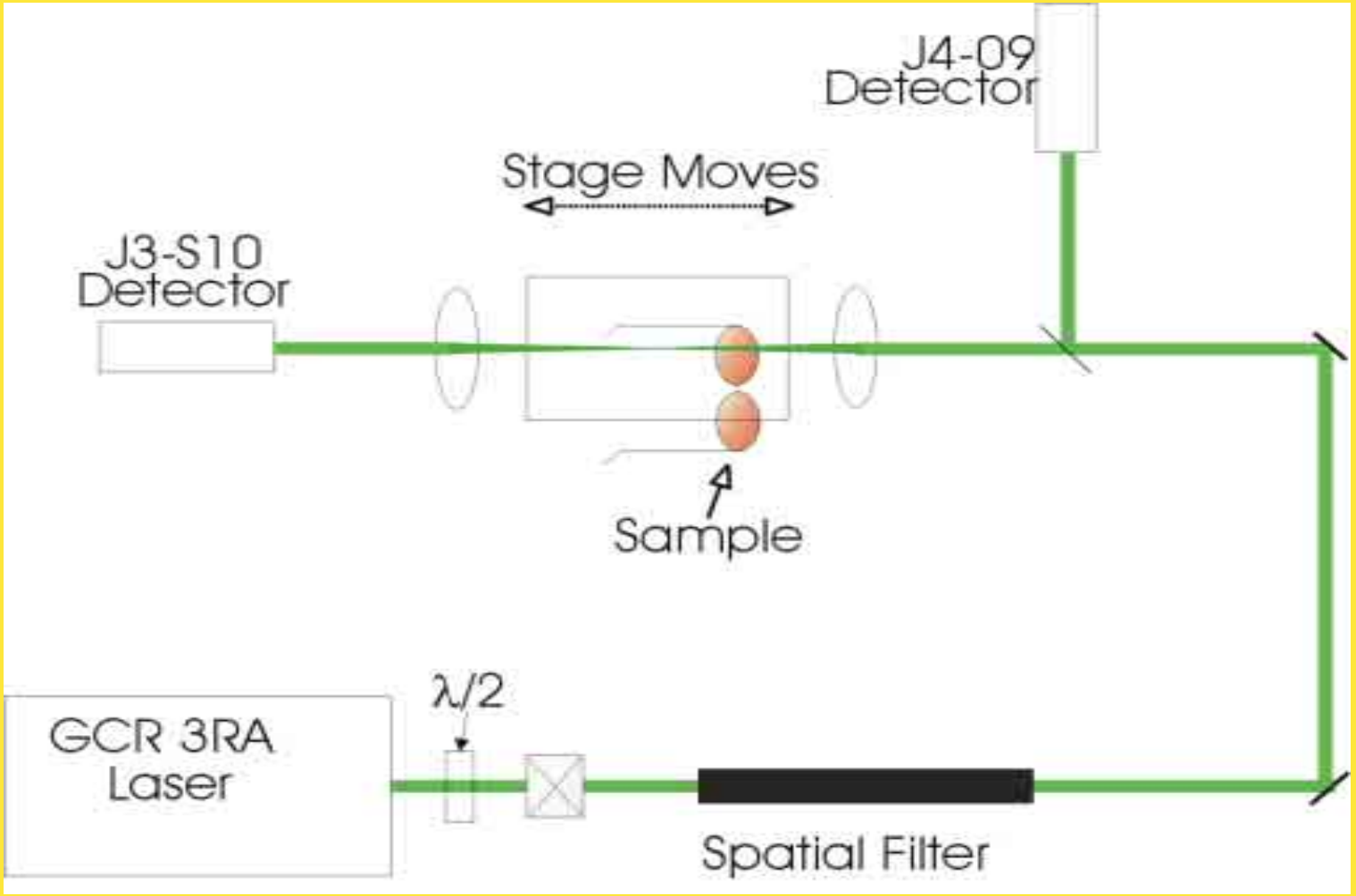
System Layout



Data Collection

- Laser
  - Nd:YAG (1064 nm, 532 nm)
  - 5ns, 100ps
- Energy Measurement
  - Ratiometer (10-100 μJ)
  - Molectron (J3-S10, J4-09)
- Beam Diameter
  - 2- 4 mm
- Software
  - LabVIEW

Summary of Samples Tested

Code	5ns 532	5ns 1064	100ps 532	100ps 1064
SAMPLE A (P)	X		X	X
SAMPLE B (G)	X		X	
SAMPLE C (G)	X		X	
SAMPLE D (G)			X	
SAMPLE E (P)				X
SAMPLE H (G)				X
SAMPLE I (P)				X
SAMPLE J (G)		X		X
SAMPLE K (P)		X		X
SAMPLE L (P)		X		X
SAMPLE M (P)	X		X	
SAMPLE S (P)			X	
SAMPLE T (P)			X	
SAMPLE KG3 (G)		X		X

No Effect
Decreased Transmittance
Bleaching

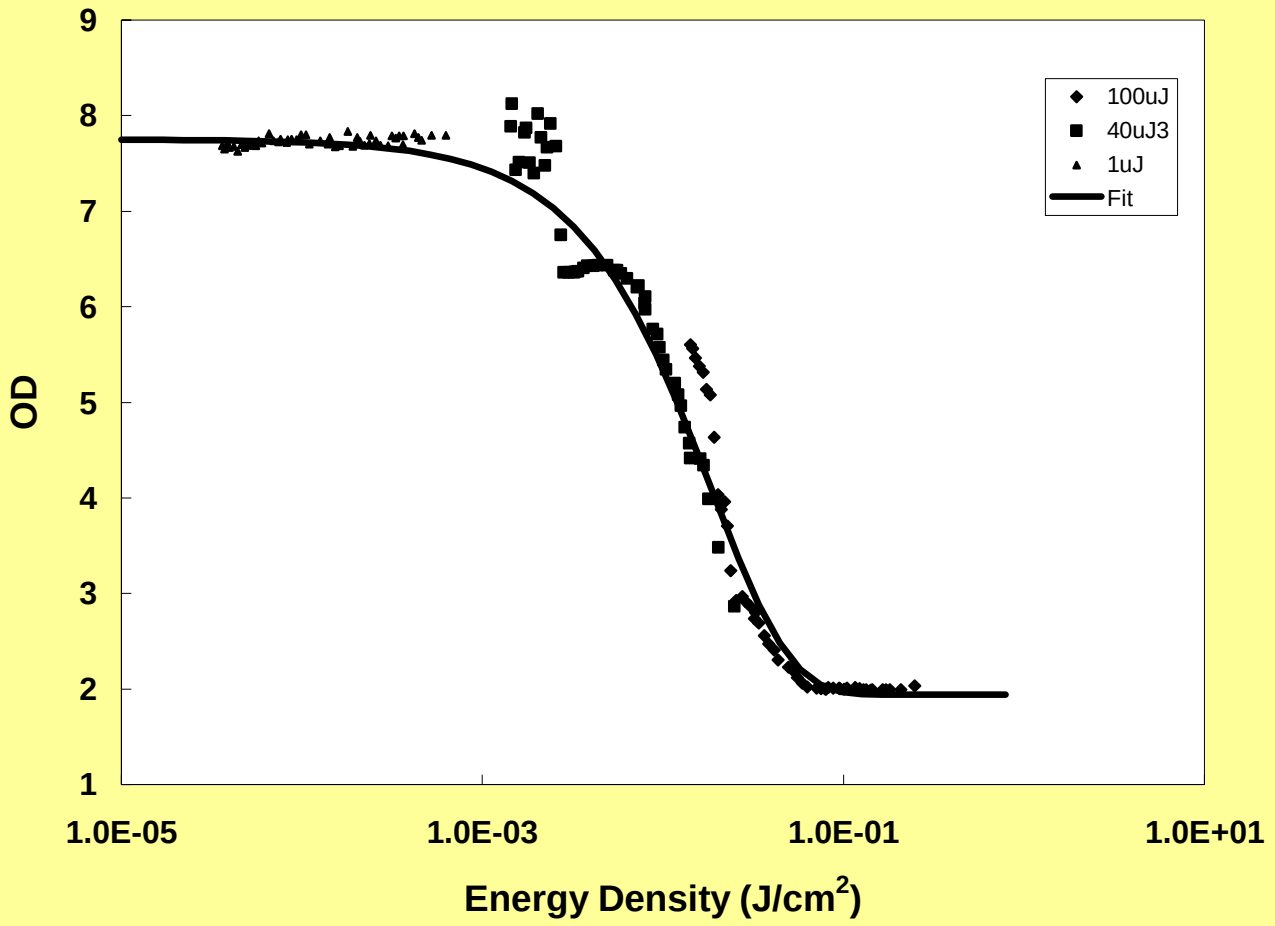
1×10^{-5} to 1 J/cm^2

1×10^{5} to 1×10^{7} W/cm^2

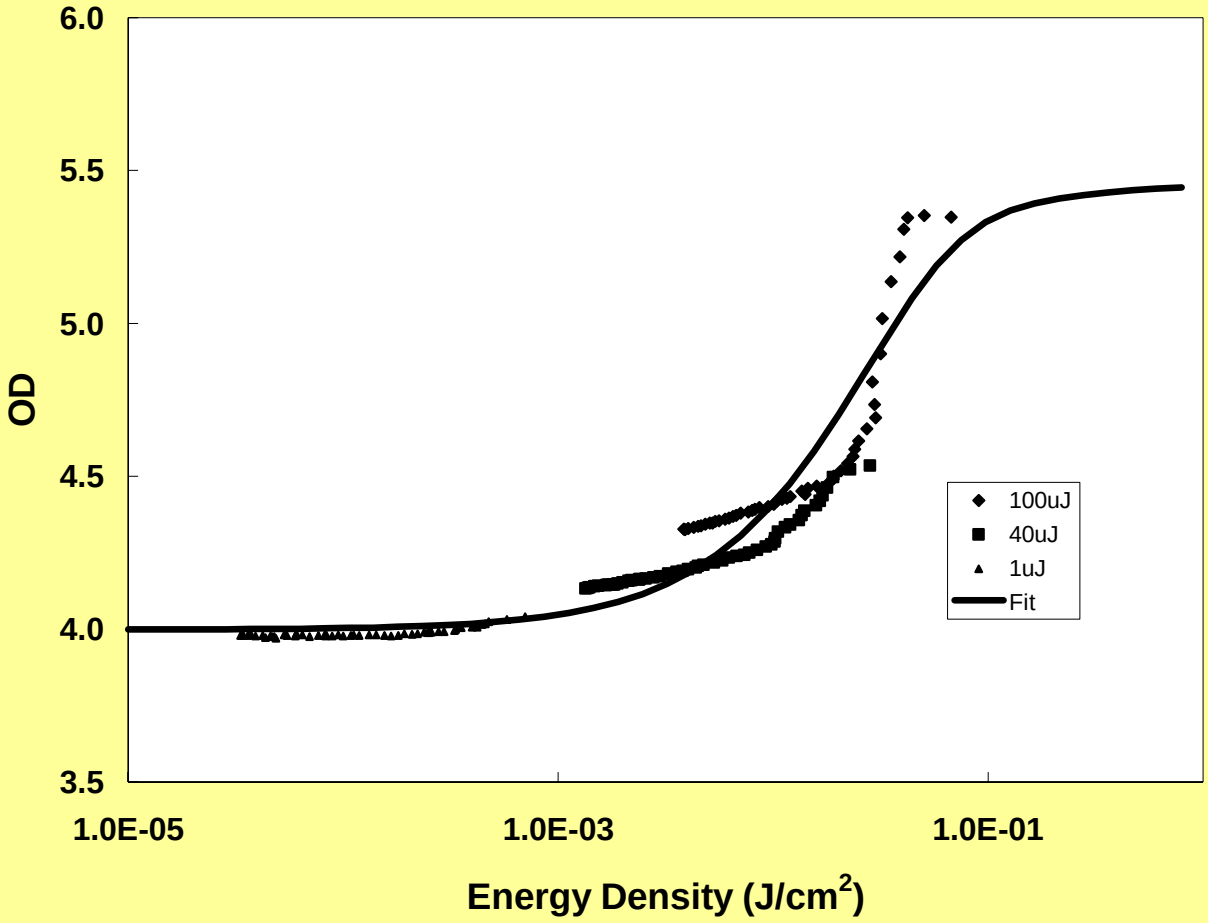
1×10^{-5} to 1 J/cm^2

1×10^{4} to 1×10^{8} W/cm^2

“Bleaching” of glass filter (Sample D)



Increased optical absorption in plastic (Sample A).



Modeling

$$T = \frac{E(x - x_0)}{E(x_0)} = \exp[-\alpha \cdot (x - x_0)]$$

$$\alpha = N_0 \cdot \sigma_0 + N_1 \cdot \sigma_1$$

$$N_0 = \frac{N\sigma_0}{\sigma_0 + \sigma_1 + \frac{1}{E \cdot \tau}} \exp\left[\left(-E(\sigma_0 + \sigma_1) - \frac{1}{\tau}\right)t\right] + \frac{N(E\sigma_1\tau + 1)}{E\tau(\sigma_0 + \sigma_1) + 1}$$

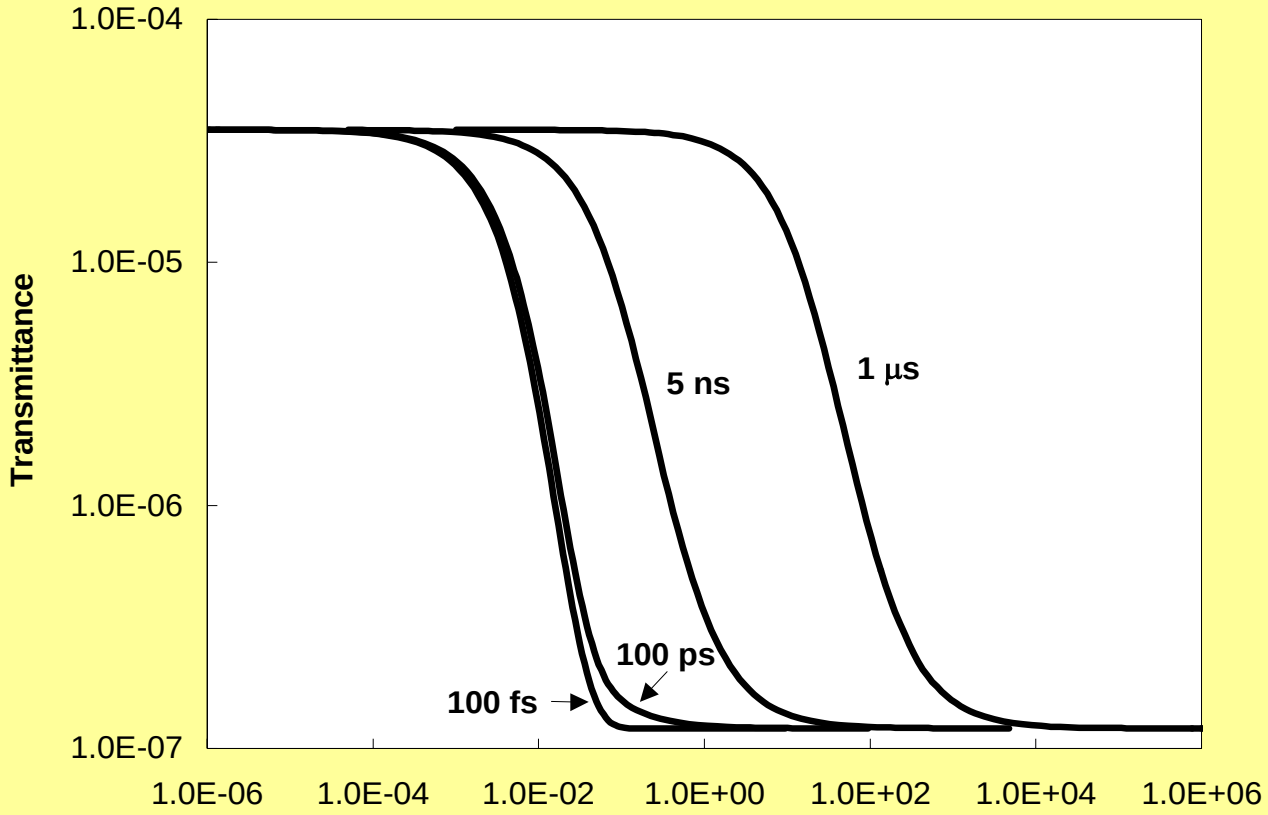
$$N = N_0 + N_1$$

W. Koschinski, et al, ILSC, 1997

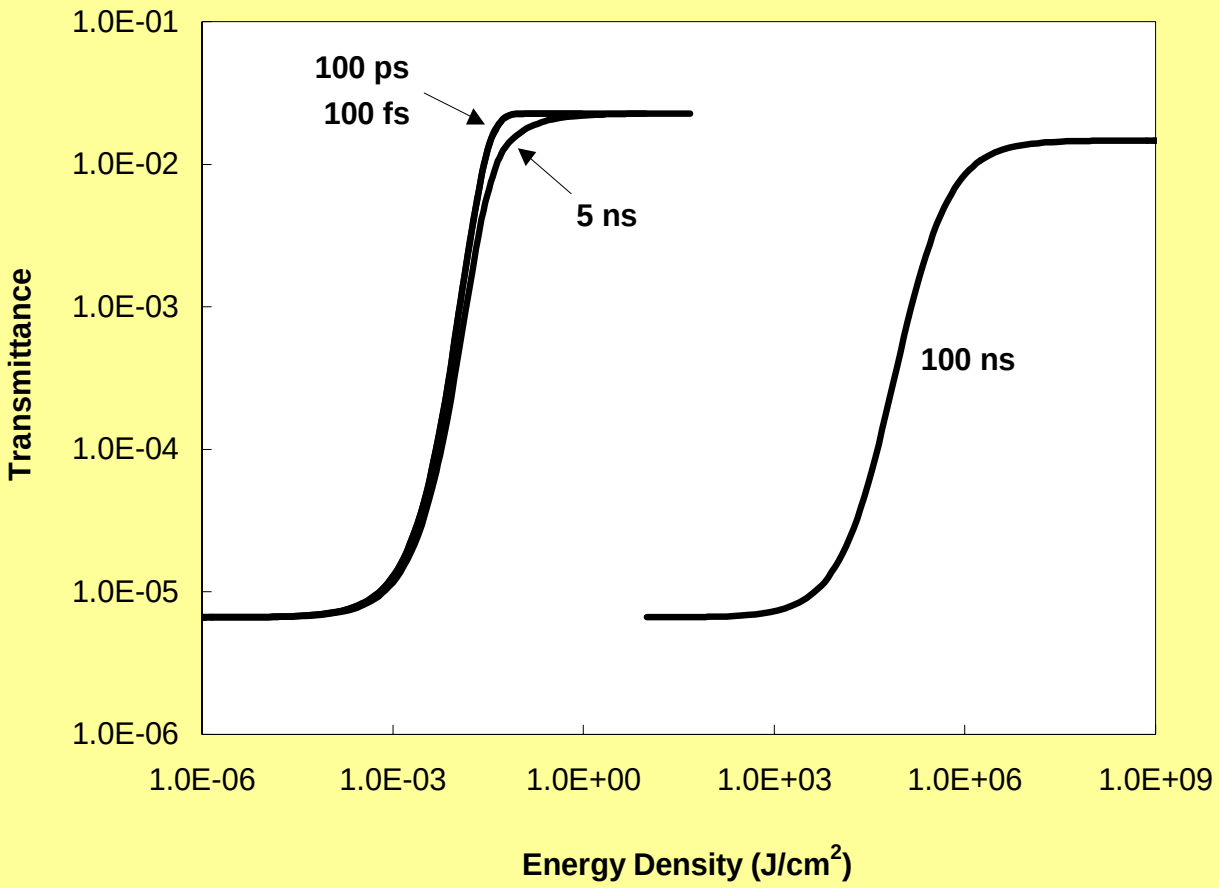
Modeling Results for Selected Samples

Sample ID	Material Type	Sample Thickness (mm)	Wave-length (nm)	N (cm^{-3})	t (s)	τ (s)	σ_0 (cm^{-2})	σ_1 (cm^{-2})
A	Polycarb	3.0	532	6.6E+18	5.0E-9	3.35E-10	5.18E-18	1.80E-17
A	Polycarb	3.0	532	6.6E+18	1.0E-10	3.35E-10	4.65E-18	1.00E-17
B	Glass	1.0	532	3.1E+18	5.0E-9	9.60E-08	3.80E-17	2.60E-18
B	Glass	1.0	532	4.5E+18	1.0E-10	1.50E-08	2.65E-17	5.70E-18
D	Glass	3.0	532	3.4E+18	1.0E-10	8.00E-08	1.75E-17	2.50E-18
H	Glass	2.0	1064	6.5E+18	1.0E-10	9.80E-09	5.10E-18	1.60E-16

Predicted effects of pulse duration on transmittance curves (Sample A).



Predicted effects of pulse duration on bleaching curves (Sample B).



Conclusions

Effects of short pulse, high irradiance exposures to laser filters can be significant.

It may be possible to identify a fixed set of parameters describing transmittance for any pulse duration and energy density.

When collecting data, it is essential to increase irradiance to the point where bleaching levels off.

Acknowledgements

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