

Today

Homework

- I have provided a Laser Safety bulletin online; please read. You'll need to inspect the light show laser in the lab.

Lab: Continue project

- Finish and test your driver circuits.
 - Offset & rescale (0...5V) \rightarrow (-1...+1V)
 - Active filter (mirror system bandwidth \sim 200Hz; put your cutoff somewhat higher)
 - Remember that the active filter will probably have gain $k \neq 1$.
 - Power amp
- Get your animation working on the Arduino.
 - What if my circuit doesn't work yet?

Lecture

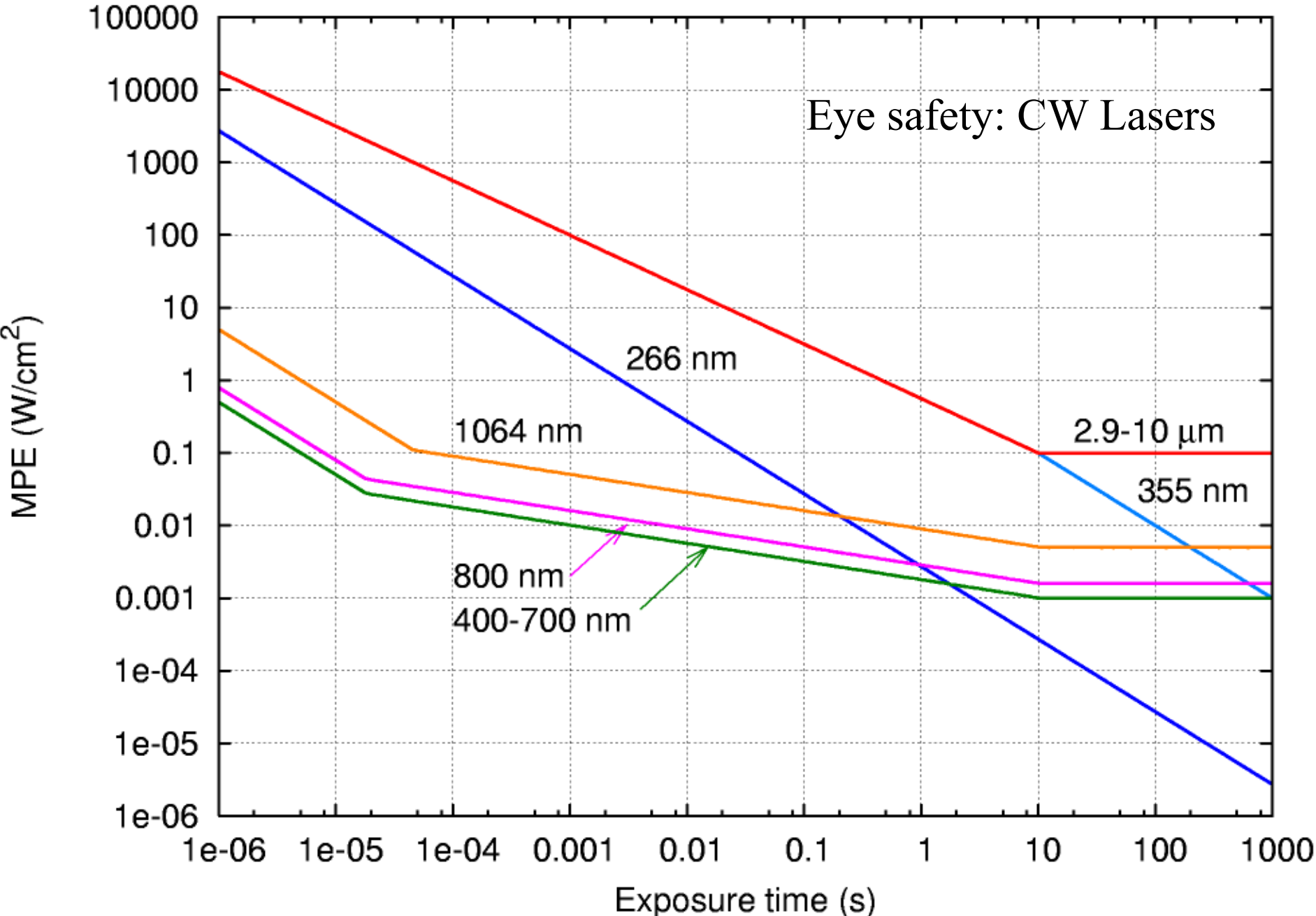
- Laser Safety
- A bit more on Arduino (if time allows)

Evaluations

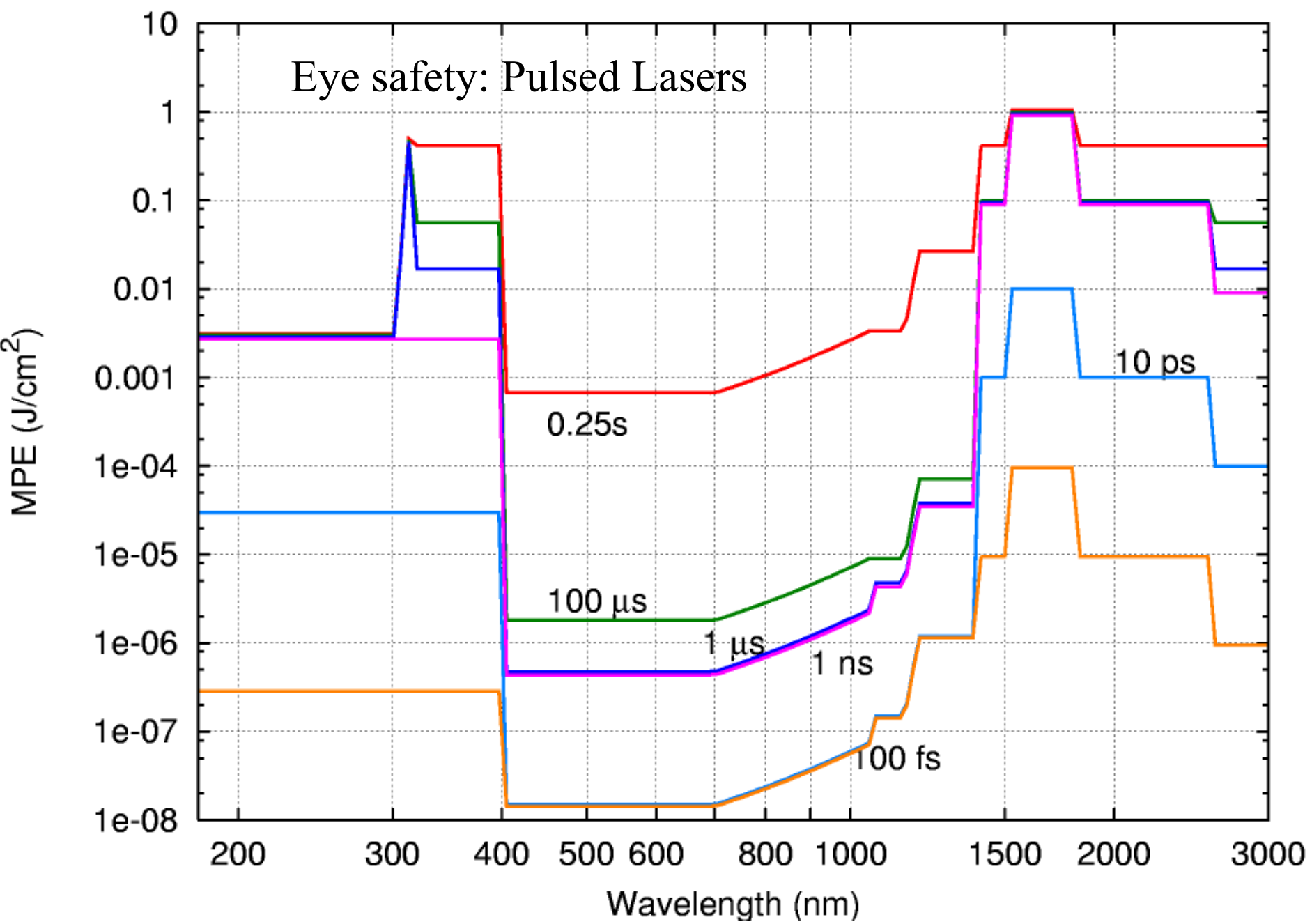
Laser Danger

- The two main hazards for the lasers we use are:
 - *Eye Damage and Electrocution.*
- Lasers are classified from Class I (safe) to Class IV (very dangerous).
- Red HeNe Lasers with output powers over 1mW are class IIIB lasers.
- Class IIIB lasers can cause permanent retinal damage if an undiverged beams enters your eye.
- If the beam is diverging, lasers up to 25mW will likely not cause permanent damage (assuming the subject blinks before a significant amount of energy enters the eye and the subject isn't purposely staring into the beam).
- Undiverged beams can cause eye damage at low powers.
- Laser power supplies operate at up to several thousand volts.
- The Argon laser and Ti:Sapphire lasers are class IV!!!!

Eye safety: CW Lasers



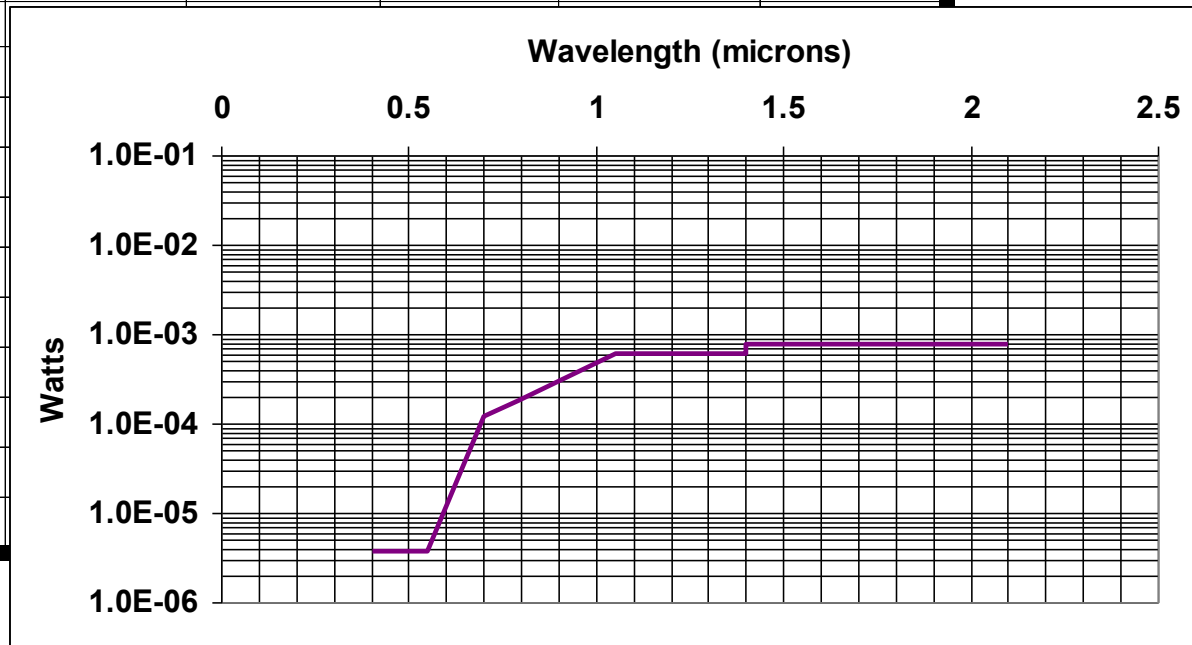
Eye safety: Pulsed Lasers



Laser Safety – Class I Lasers

**A class 1 laser is safe under all conditions of normal use:
The maximum permissible exposure (MPE) cannot be exceeded.**

duration	t	1.0E+03	sec	t>10-9	t<30000	for Density
					t<1000	for energy/power
Eye MPE for direct ocular Exposure (ANSI Z136.1-1980 table 5)						
μm	μm	cm	J/cm ²	W/cm ²	J	W
lambda range	lambda	d	energy den	power den	energy	power
.4-.55	0.4	0.7	1.0E-02	1.0E-05	3.8E-03	3.8E-06
.4-.55	0.55	0.7	1.0E-02	1.0E-05	3.8E-03	3.8E-06
.55-.7	0.55	0.7	1.0E-02	1.0E-05	3.8E-03	3.8E-06
.55-.7	0.7	0.7				
.7-1.051	0.7	0.7				
.7-1.051	0.79	0.7				
.7-1.051	1.051	0.7				
1.051-1.4	1.051	0.7				
1.051-1.4	1.4	0.7				
1.4 -100	1.4	0.1				
1.4 -100	1.53	0.1				
1.54	1.54	0.1				
1.4 -100	1.55	0.1				
1.4 -100	2.1	0.1				



Laser Safety – Class 2 Lasers

A Class 2 laser is safe because the blink reflex will limit the exposure to no more than 0.25 seconds. It only applies to visible-light lasers (400–700 nm).

Class-2 lasers are limited to 1 mW continuous wave (or more if the emission time is less than 0.25 seconds) (or if the light is not spatially coherent).

Intentional suppression of the blink reflex could lead to eye injury. Many laser pointers are class 2.

	A	B	C	D	E	F	G	H
1	duration	t	2.5E-01	sec	t>10-9	t<30000	for Density	
2						t<1000	for energy/power	
3	Eye MPE for direct ocular Exposure (ANSI Z136.1-1980 table 5)							
4	μm	μm	cm	J/cm ²	W/cm ²	J	W	
5	lambda range	lambda	d	energy den	power den	energy	power	
6	.4-.55	0.4	0.7	6.4E-04	2.5E-03	2.4E-04	9.8E-04	3.8E-06
7	.4-.55	0.55	0.7	6.4E-04	2.5E-03	2.4E-04	9.8E-04	3.8E-06
8	.55-.7	0.55	0.7	6.4E-04	2.5E-03	2.4E-04	9.8E-04	3.8E-06
9	.55-.7	0.7	0.7	6.4E-04	2.5E-03	2.4E-04	9.8E-04	1.2E-04

Laser Safety Rules

- 1) Do not view any laser beams directly.
- 2) Do not operate lasers without the beams being well controlled.
- 3) Do not add mirrors or other optics to set-up.
- 4) Keep shiny objects out of way of beam.
- 5) Do not operate laser with cover off or with wires exposed or disconnected.
- 6) Keep beams controlled at a uniform height and block spurious beams.
- 7) Don't sit with eyes at beam level.
- 8) Beware of stray reflections, especially when aligning optics. Warn other in room of any realignments.
- 9) Take off watches, bracelets and shiny rings to prevent accidental reflections.
- 10) Alert all visitors to the potential dangers and precautions

Project

- Any questions?
- Want an A? Review the rubric (in the project start presentation, online).
- Do you know how to offset the Arduino signal from $(0 < V < 5)$ to $(-1 < V < 1)$?

Arduino Examples (time permitting)

- AnalogRead:

<http://arduino.cc/en/Reference/AnalogRead>

- Making music with Arduino
- Einstein2.ino, Einstein3.ino

Evaluations