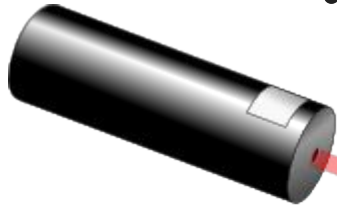


# LASER CYCLOPS

13 NOVEMBER 2018



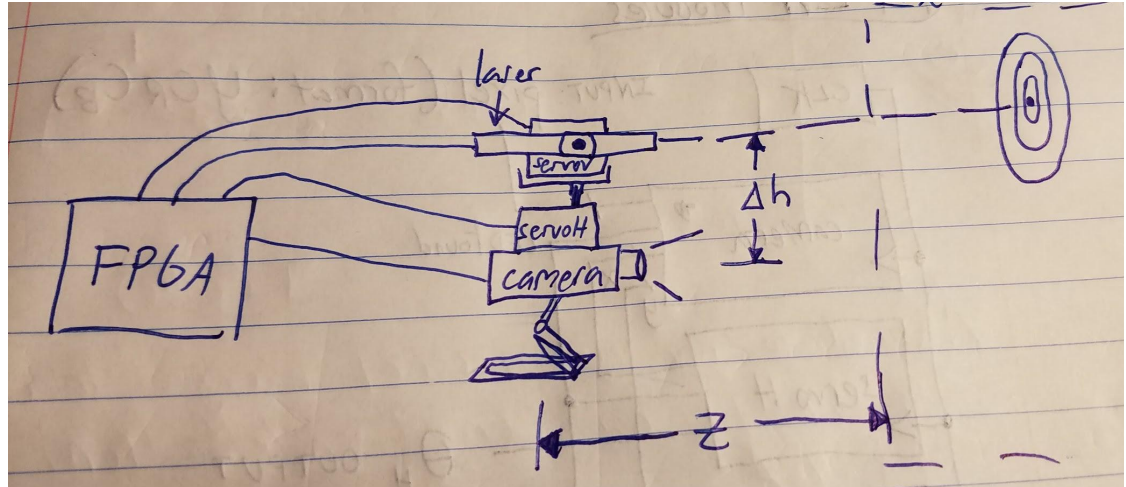
**Carlos Cuevas & Cody Winkleblack**

# OVERVIEW

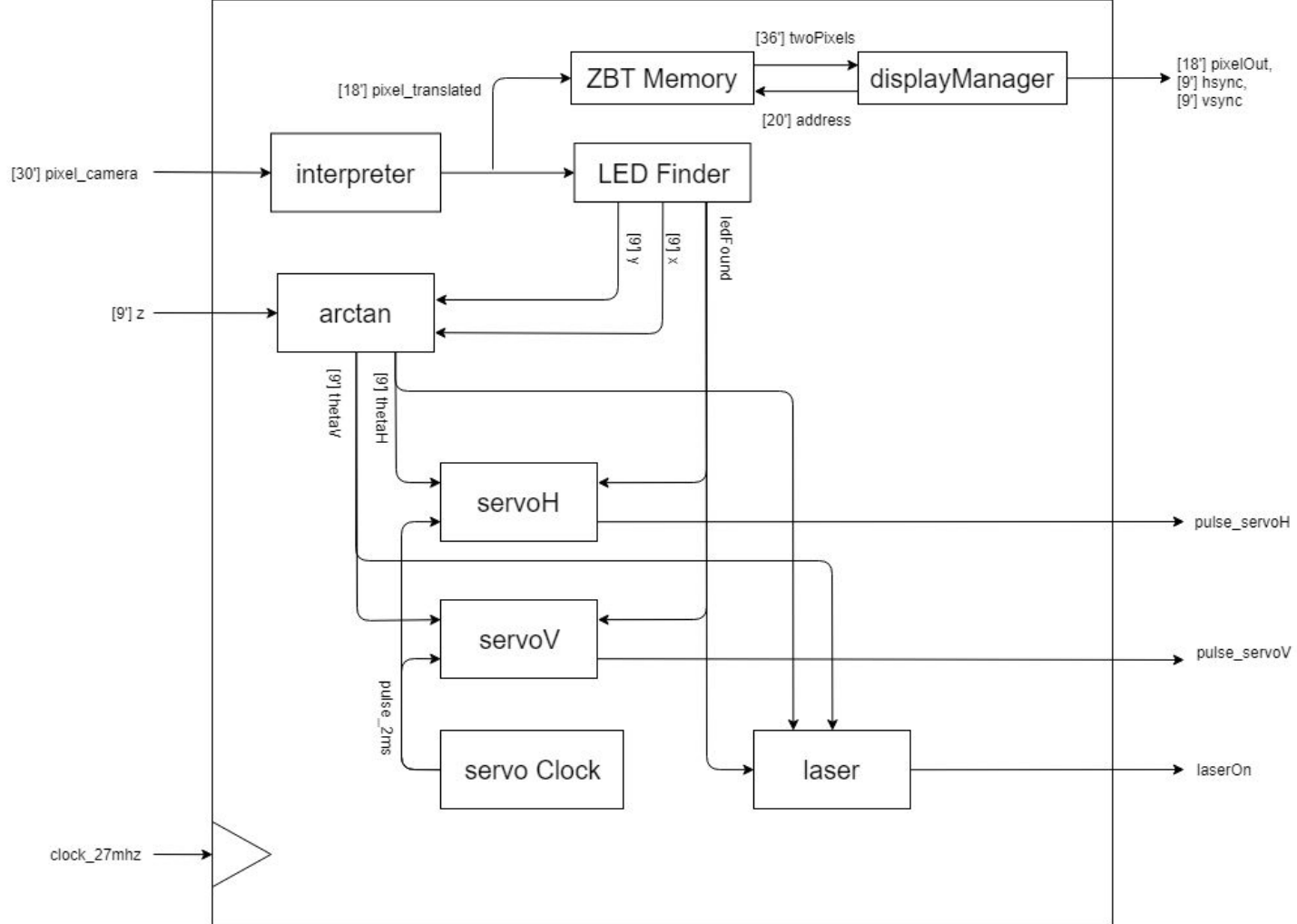
- **Use a NTSC camera to detect a target and, given the depth, fire a laser at it.**
- Infrared LED is used on the target; filter allows only infrared rays through.
- Two servos are used to aim the laser.
- Laser should only be firing when over the LED.
- VGA display will also be used to see where the FPGA thinks the target is at, as well as for later extension goals.

# HARDWARE

- [2] Servos
- [1] 523nm Laser
- [1] NTSC Camera
- [1] Infrared filter
- [1] Circular Target
- [1] Infrared LED (at center of target)
- 3D Printed Components connecting the camera, laser, and servos

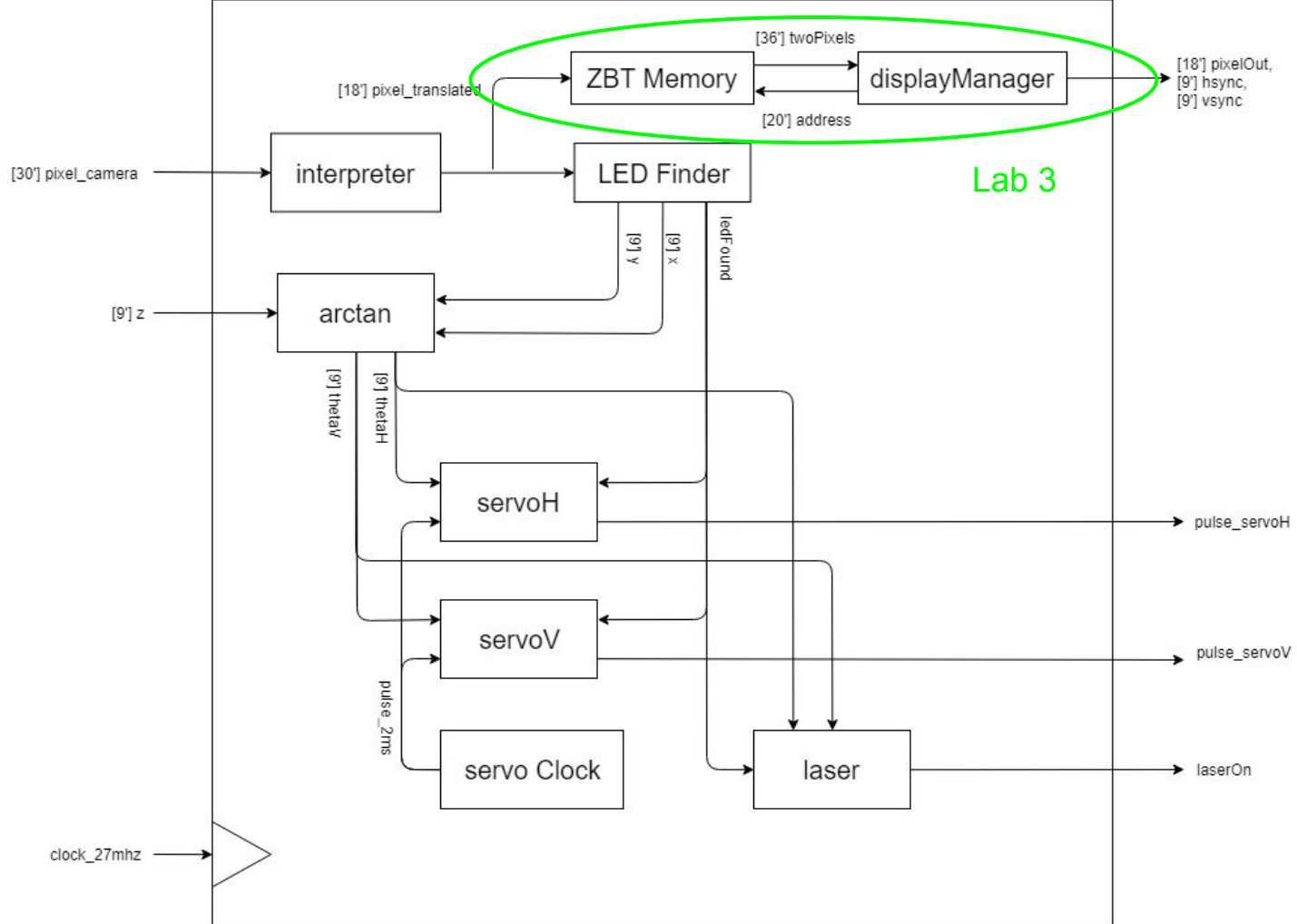


# FPGA MAJOR MODULES



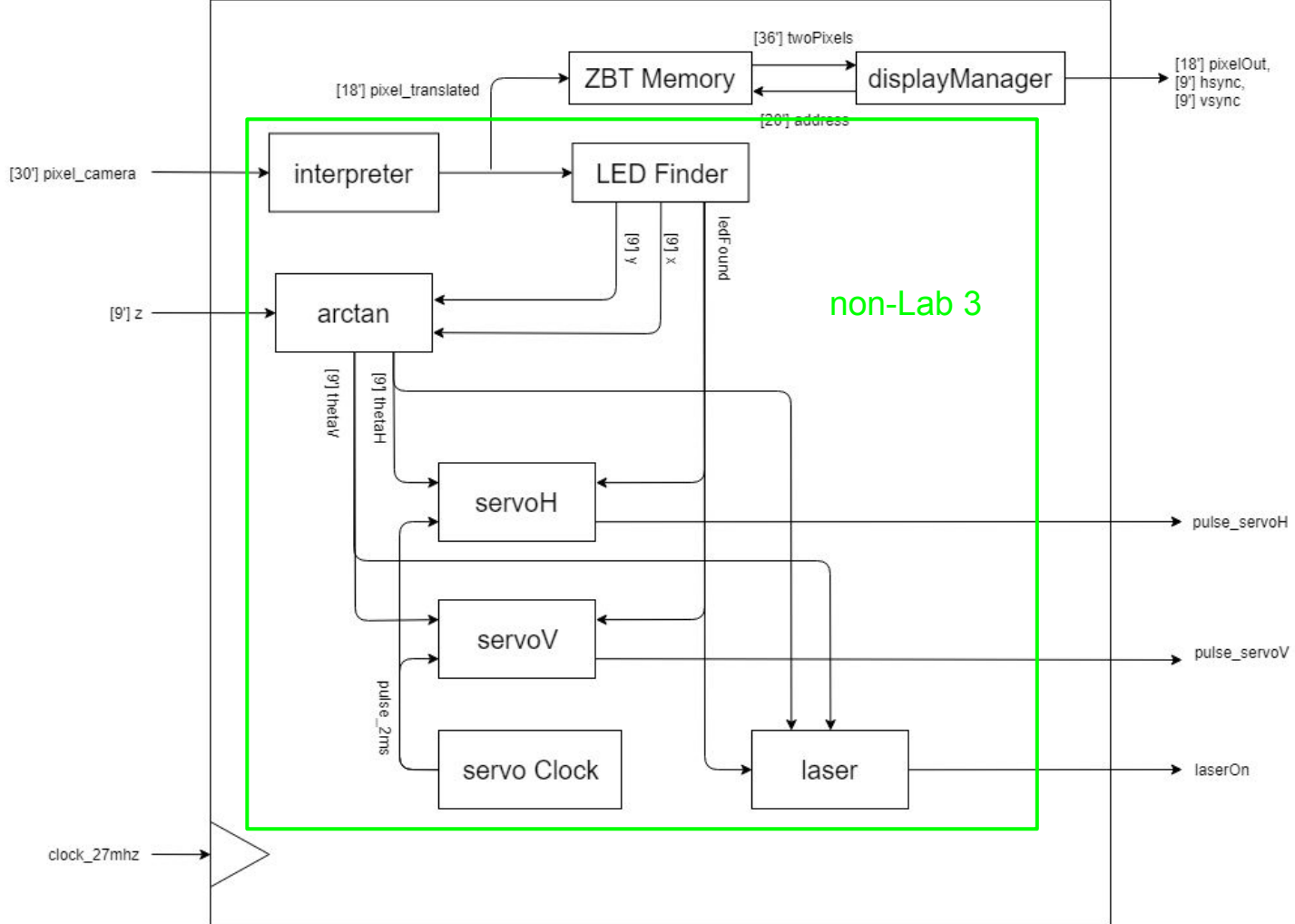
Laser Cyclops FPGA

# FPGA MAJOR MODULES



Laser Cyclops FPGA

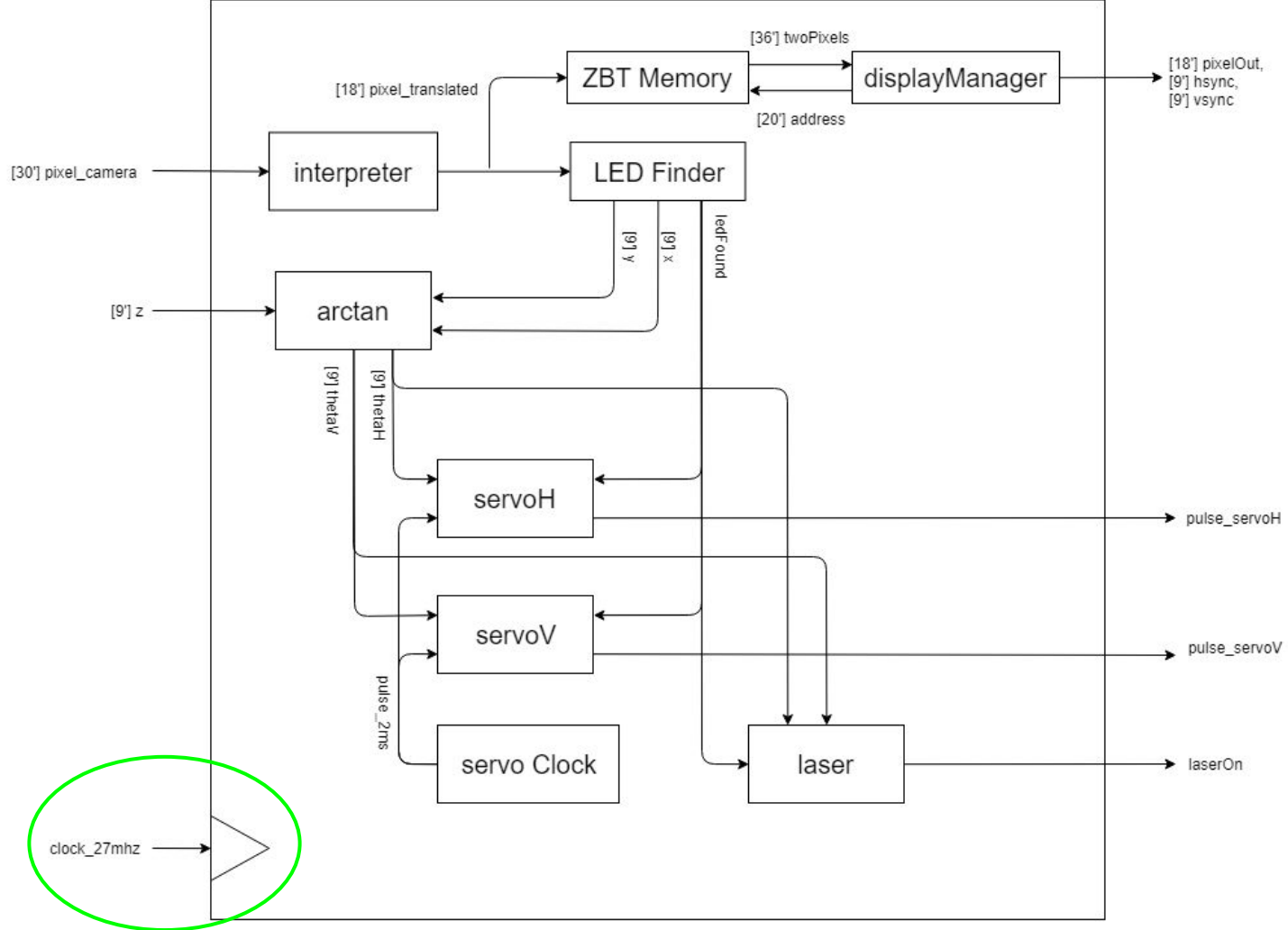
# FPGA MAJOR MODULES



Laser Cyclops FPGA

# FPGA MAJOR MODULES

TiK-ToK



# MODULE (INTERPRETER)

Input = [29:0] YCrCb

Output = [17:0] {R[9:4], G[9:4], B[9:4]}

Equations:

$$r = 1.164*(y-16) + 1.596*(Cr-128)$$

$$g = 1.164*(y-16) - 0.813*(Cr-128) - 0.391*(Cb-128)$$

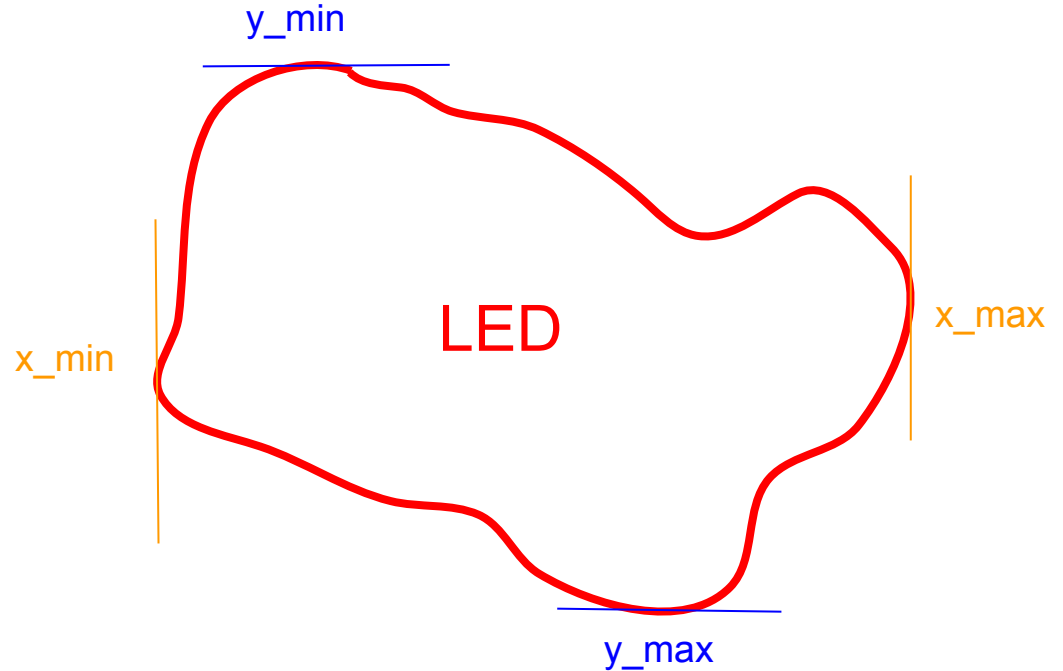
$$b = 1.164*(y-16) + 2.018*(Cb-128)$$



# MODULE (LED FINDER)

```
x = (x_min + x_max) >> 1
```

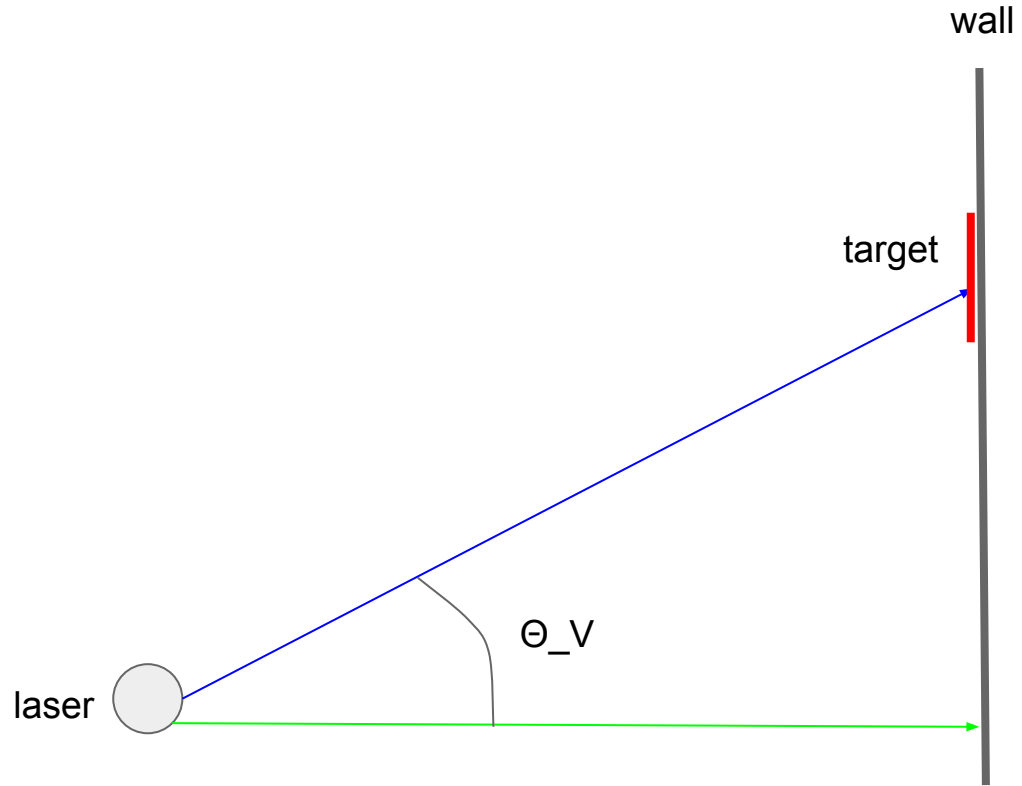
```
y = (y_min + y_max) >> 1
```



# MODULE (ARCTAN)

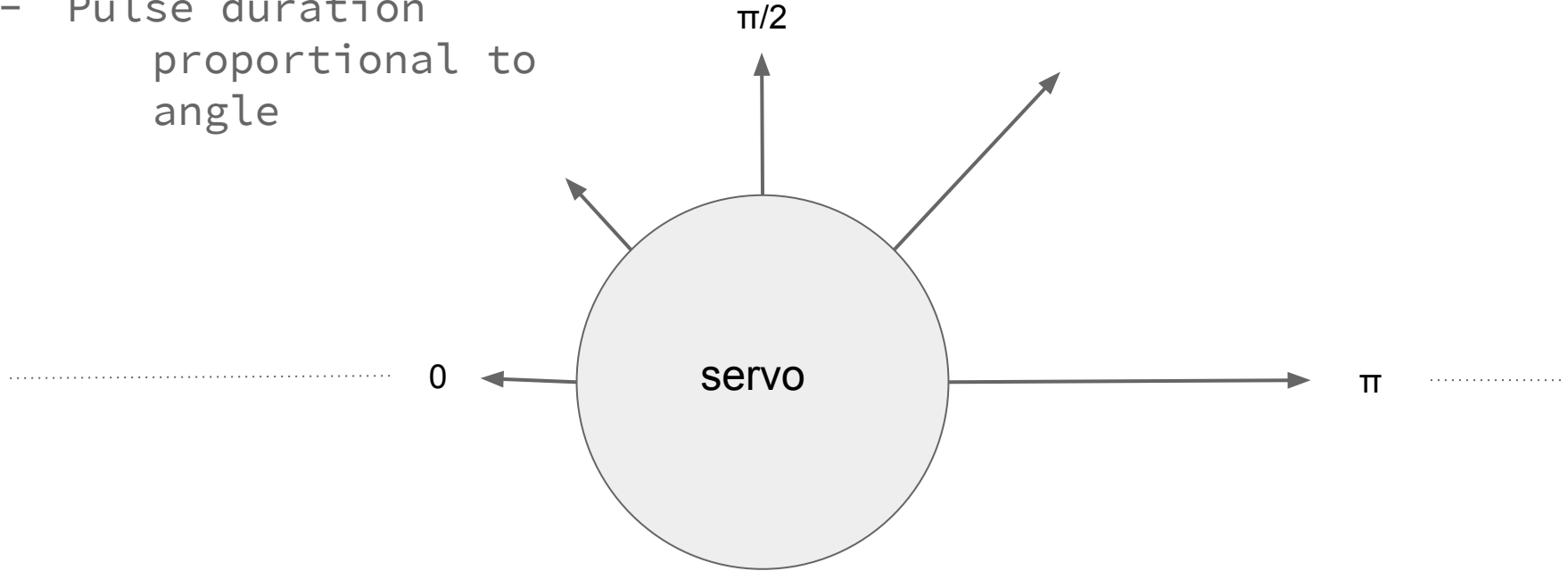
$$\theta_H = \arctan(x/z)$$

$$\theta_V = \arctan(y/z)$$



# MODULE (SERVO)

- Pulse every 2ms
- Pulse duration proportional to angle



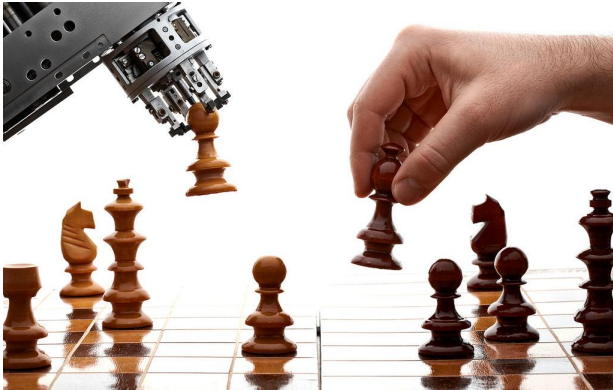
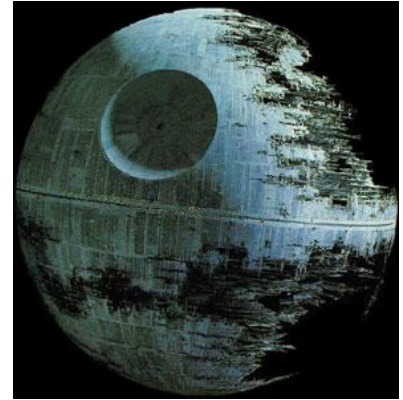
# MODULE (LASER)

```
if(!ledFound &&  
    abs( $\Theta_H[n-1]$  -  $\Theta_H[n]$ ) <=E &&  
    abs( $\Theta_V[n-1]$  -  $\Theta_V[n]$ ) <=E)  
    laserOn <= 1;  
else laserOn <= 0;
```

Parameter **E =  $\pi/180$  radians**

# REACH GOALS

- Chroma Keying
- Cross Hairs
- Image Overlay on the target
- Landscape/backdrop
- Cyclops versus Human



# IMPLEMENTATION COMPLEXITIES

- Math Module-Arctan

- Taylor Series

$$\begin{aligned}\arctan z &= z - \frac{z^3}{3} + \frac{z^5}{5} - \frac{z^7}{7} + \dots \\ &= \sum_{n=0}^{\infty} \frac{(-1)^n z^{2n+1}}{2n+1}; \quad |z| \leq 1 \quad z \neq i, -i\end{aligned}$$

- Noise from the camera -IE picking up multiple targets

- Filter before the camera
- FPGA: Take the largest feature found

- Accuracy issues (offset of laser relative to camera)

- Tweaking in Verilog, but no continuous feedback system

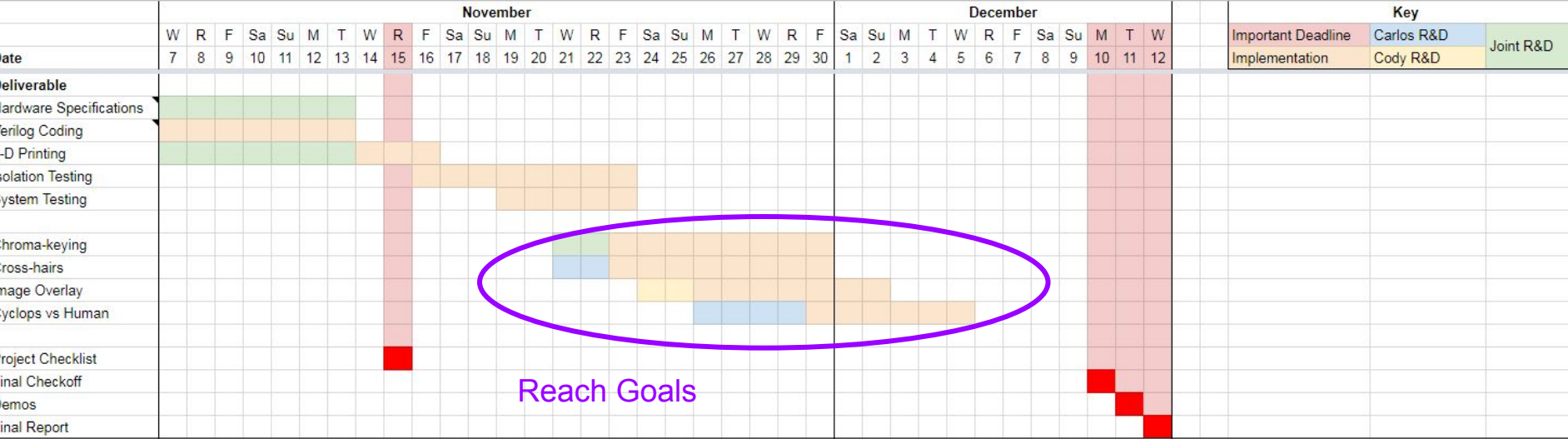
# PROJECT TIMELINE

	November																December												Key										
Date	W	R	F	Sa	Su	M	T	W	R	F	Sa	Su	M	T	W	R	F	Sa	Su	M	T	W	R	F	Sa	Su	M	T	W	Important Deadline	Carlos R&D	Implementation	Cody R&D	Joint R&D					
	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12			
<b>Deliverable</b>																																							
Hardware Specifications	Joint R&D																																						
Verilog Coding	Cody R&D																																						
3-D Printing	Joint R&D																																						
Isolation Testing																	Cody R&D																						
System Testing																	Cody R&D																						
Chroma-keying																	Cody R&D																						
Cross-hairs																	Cody R&D																						
Image Overlay																	Cody R&D																						
Cyclops vs Human																	Cody R&D																						
Project Checklist																																							
Final Checkoff																																							
Demos																																							
Final Report																																							



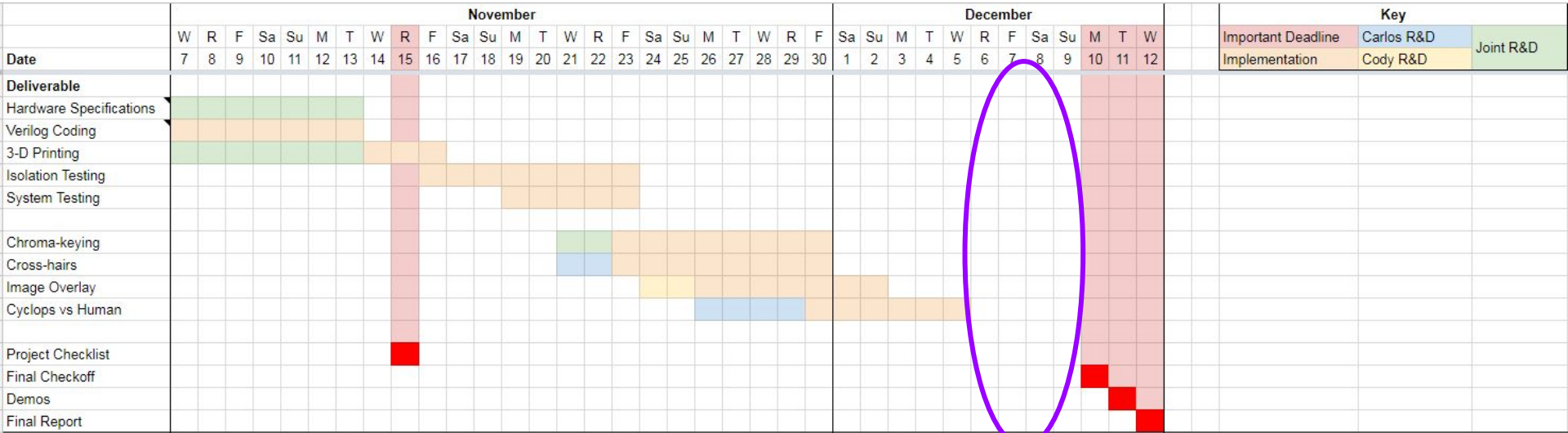


# PROJECT TIMELINE



Reach Goals

# PROJECT TIMELINE



Bug Gap



THANK YOU

QUESTIONS?

