

# 20.109

## Synthetic Biology Module

## Lecture #2

Ron Weiss

Department of Biological Engineering

MIT



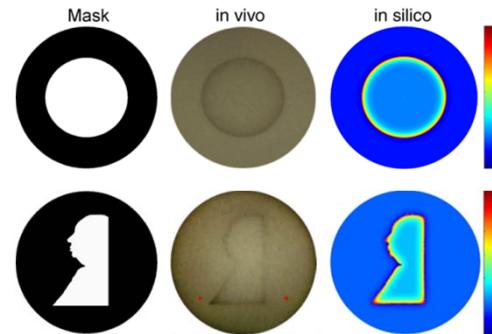
Department of  
Biological Engineering

*March 10, 2011*

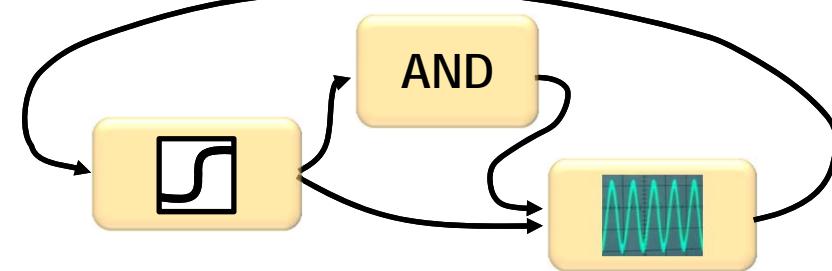


# System design and implementation

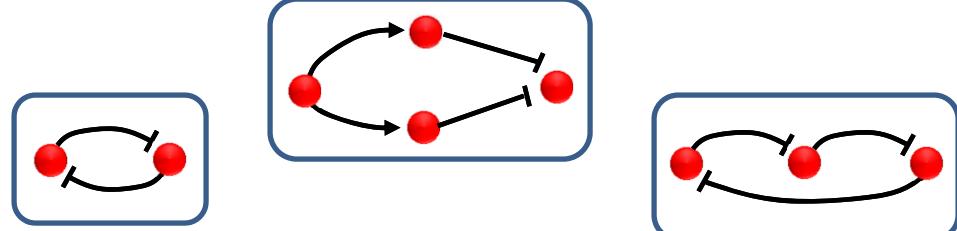
**high-level objective**



**system architecture**



**modules**



**biochemical reactions**

$$\begin{aligned}\frac{dU}{dt} &= \alpha_u I_u - \gamma_u U + D_u \nabla^2 U \\ \frac{dV}{dt} &= \alpha_v I_v - \gamma_v V + D_v \nabla^2 V\end{aligned}$$

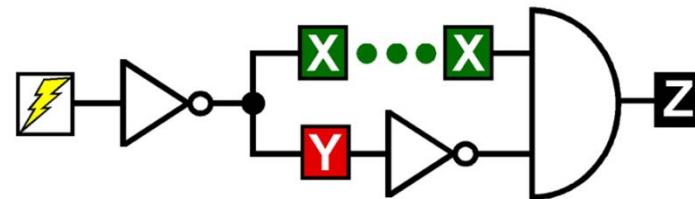
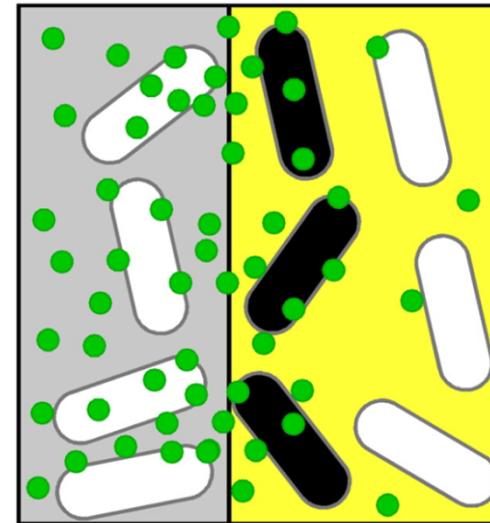
$$\begin{aligned}\frac{dI_u}{dt} &= \alpha_{iu} F_1(X_1, C) - \gamma_{iu} I_u \\ \frac{dI_v}{dt} &= \alpha_{iv} F_1(X_1, C) - \gamma_{iv} I_v \\ \frac{dC}{dt} &= \alpha_c F_2(X_2, L) - \gamma_c C\end{aligned}$$

# Genetic Edge Detection Algorithm

- Pseudocode:

```
IF NOT (light)
    produce signal
IF signal AND NOT (NOT light)
    produce pigment
```

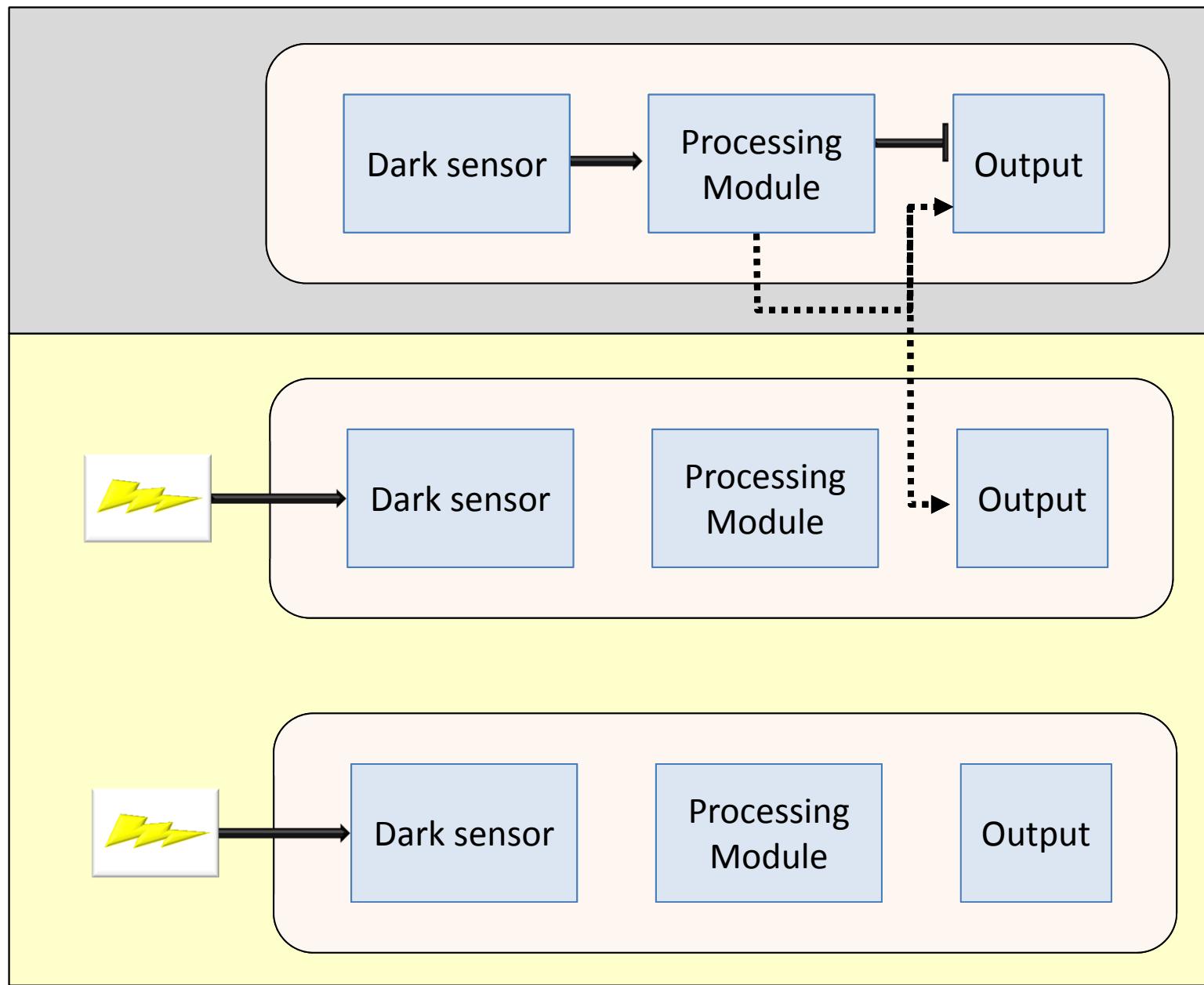
- Produce signal –  
generate diffusible  
communication signal
- Produce pigment –  
produce black pigment



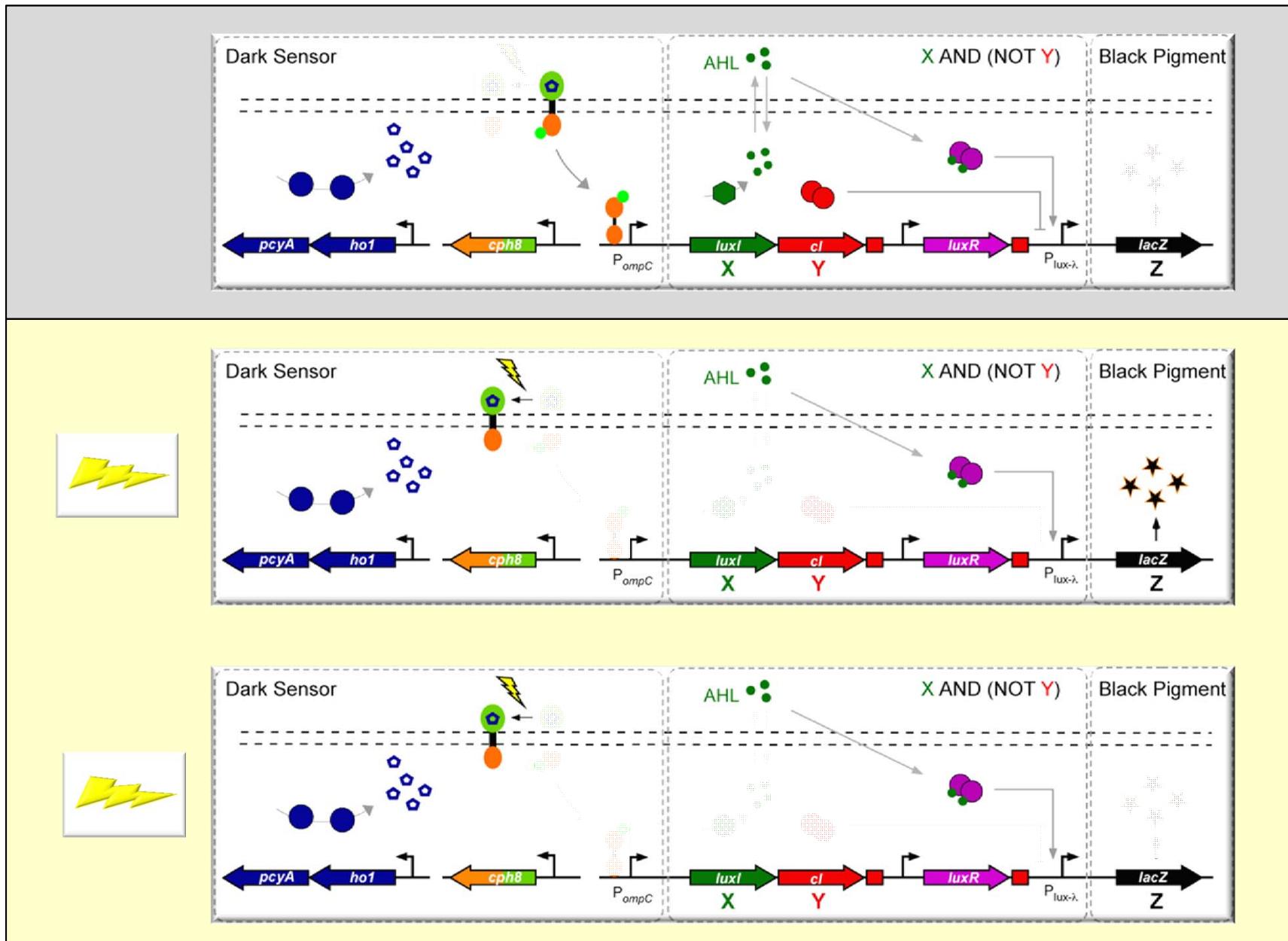
| X | Y | Z |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 1 | 0 |

A synthetic genetic edge detection program. Tabor JJ, Salis HM, Simpson ZB, Chevalier AA, Levskaya A, Marcotte EM, Voigt CA, Ellington AD. **Cell.** 2009 Jun 26;137(7):1273. Figure 1B, 1C

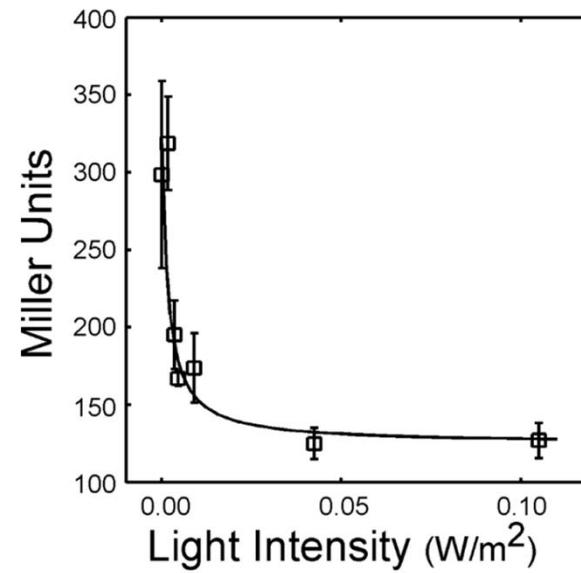
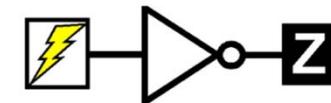
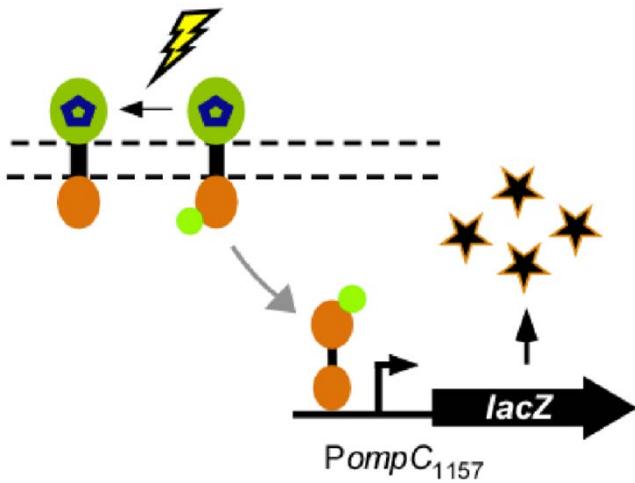
# Abstract operation of the system



# Detailed operation of the system



# Transfer Function for Dark Sensor

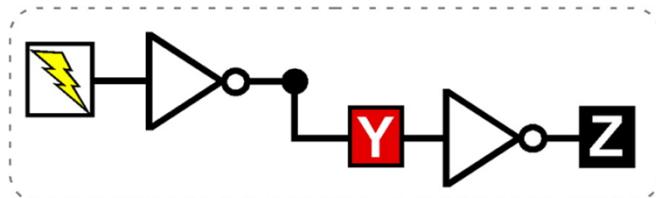


# Big money

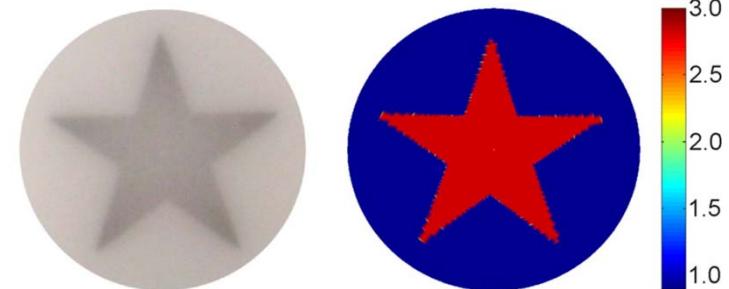
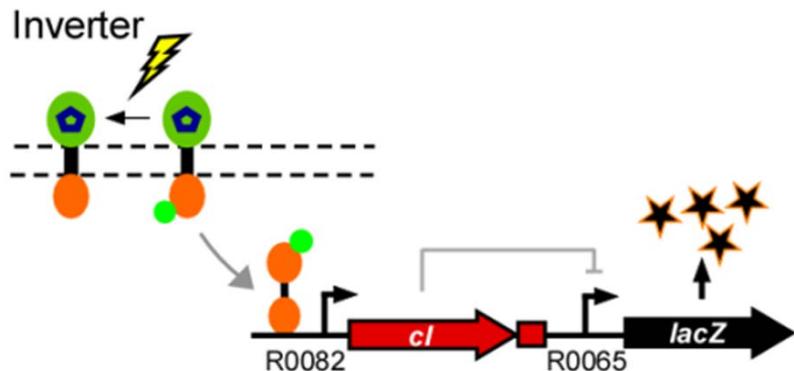
- For \$5:  
What was the incorrect slide from last lecture?

### III. Inverter

Inverter

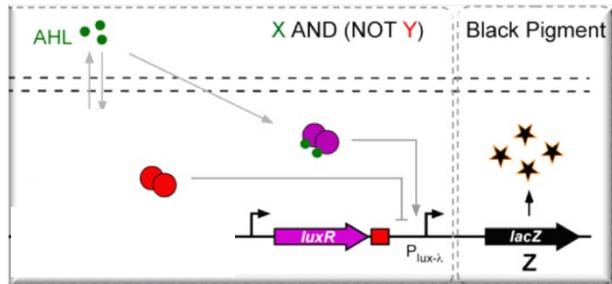


- ▶ But with R0065, B-gal should be expressed only where AHL AND NOT (NOT light)

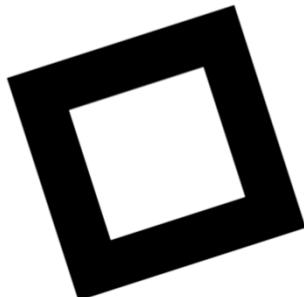


# Edge detection with idealized (Top) versus broken (bottom) pLux/cl

pLux/cl

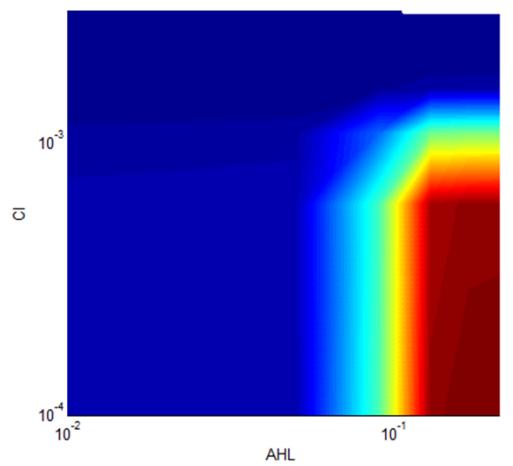


“Ideal”

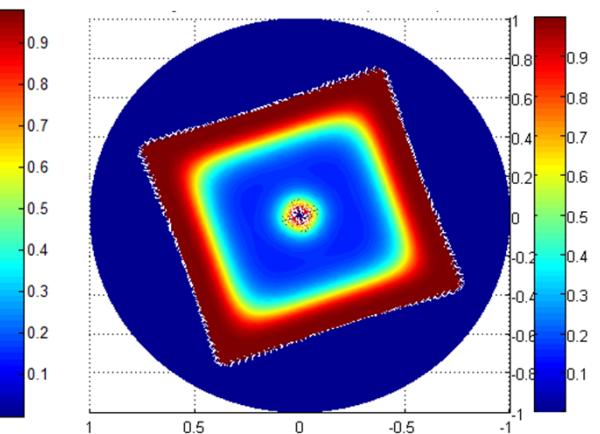


Mask

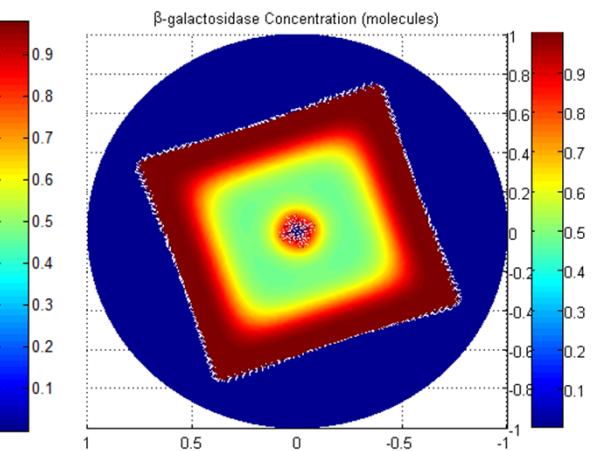
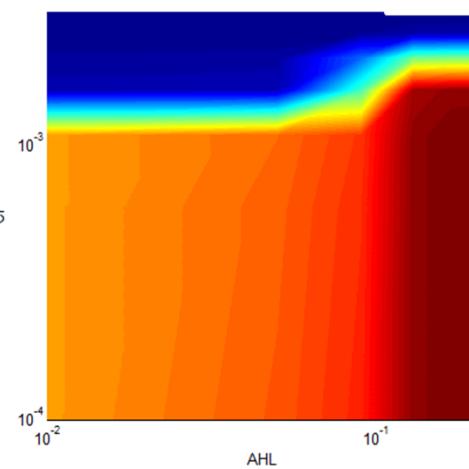
pLux/cl transfer function



B-gal behavior?

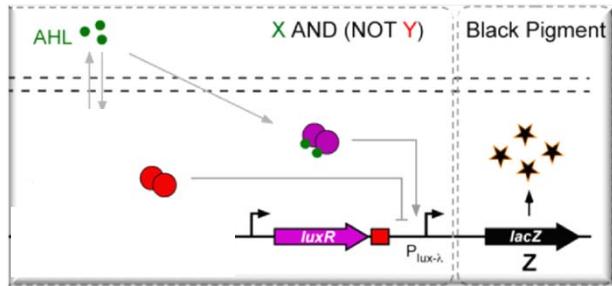


“Broken”

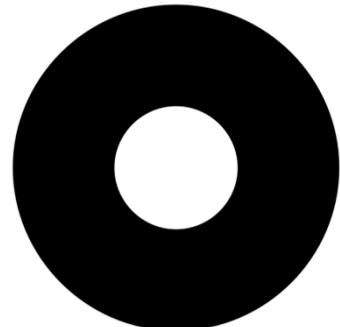


# Edge detection with idealized (Top) versus broken (bottom) pLux/cl

pLux/cl

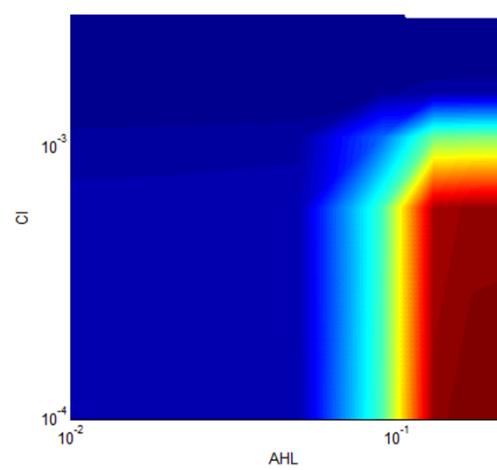


“Ideal”

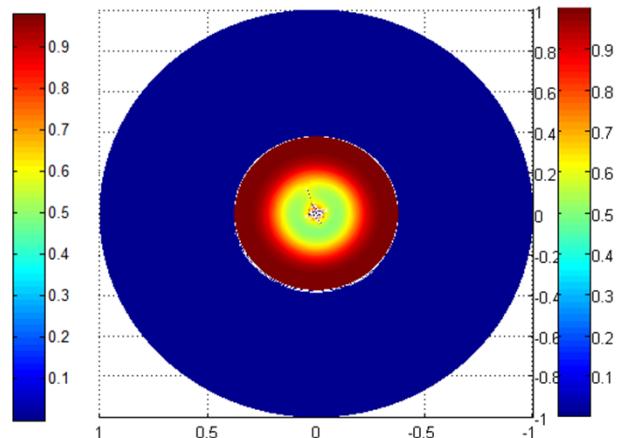


Mask

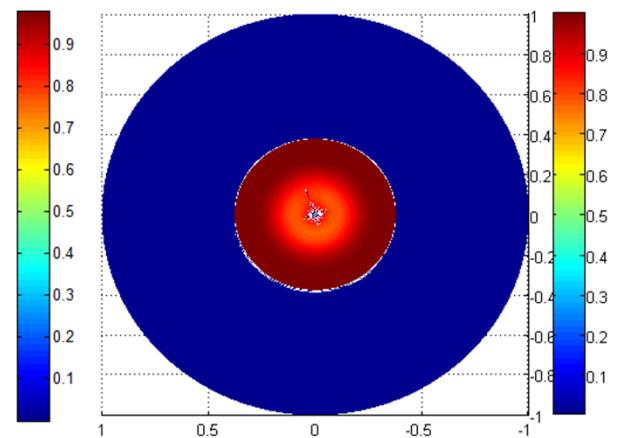
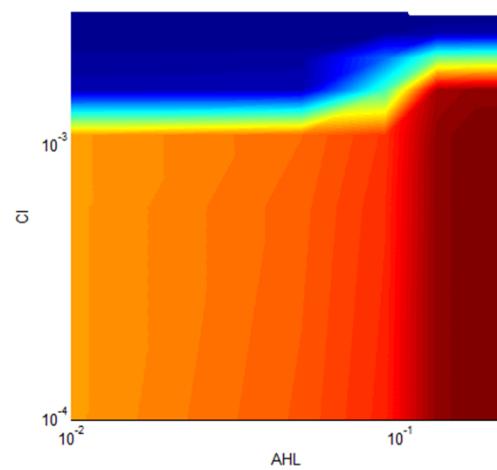
pLux/cl transfer function



B-gal behavior?

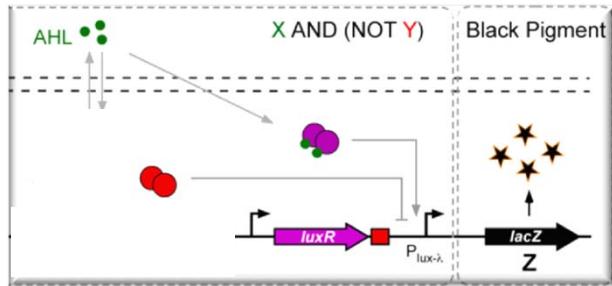


“Broken”



# Edge detection with idealized (Top) versus broken (bottom) pLux/cl

pLux/cl

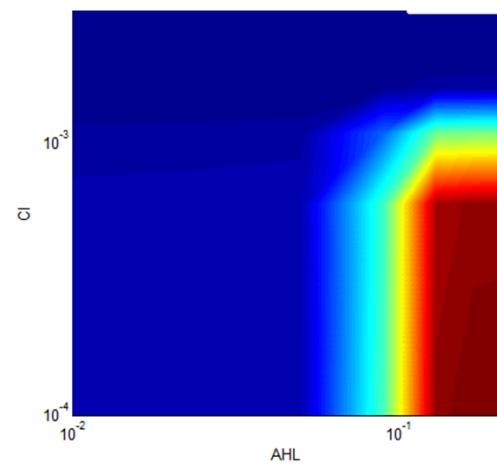


“Ideal”

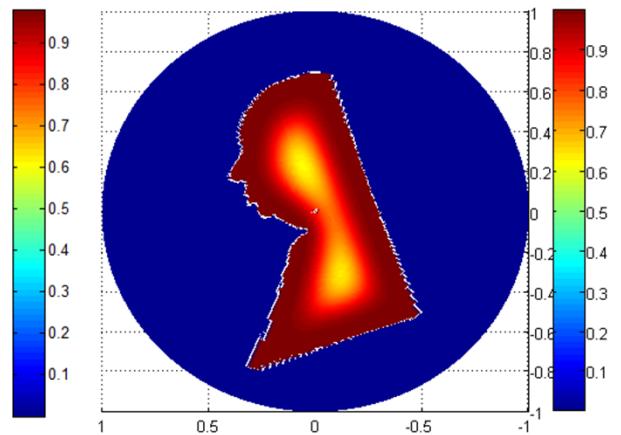


Mask

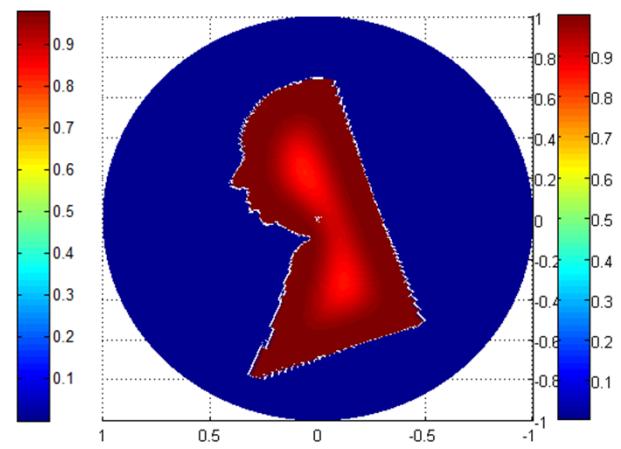
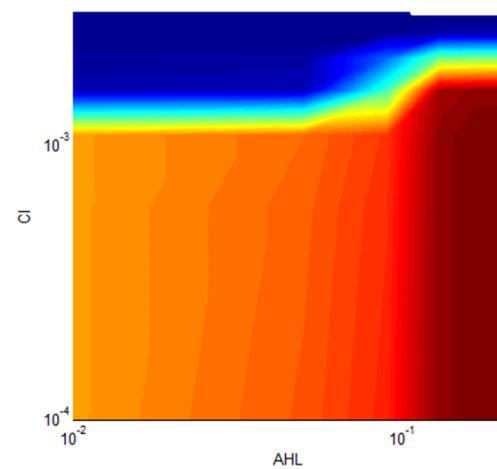
pLux/cl transfer function



B-gal behavior?

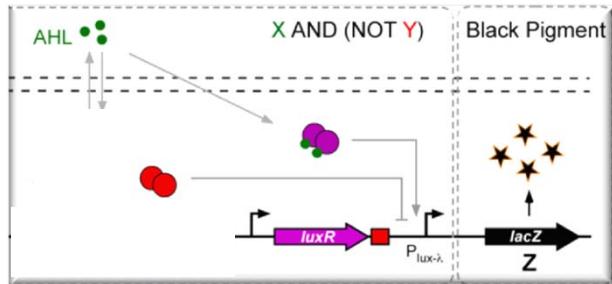


“Broken”



# Edge detection with idealized (Top) versus broken (bottom) pLux/cl

pLux/cl

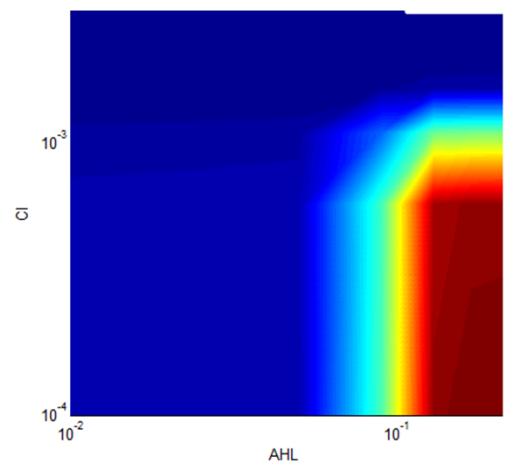


“Ideal”

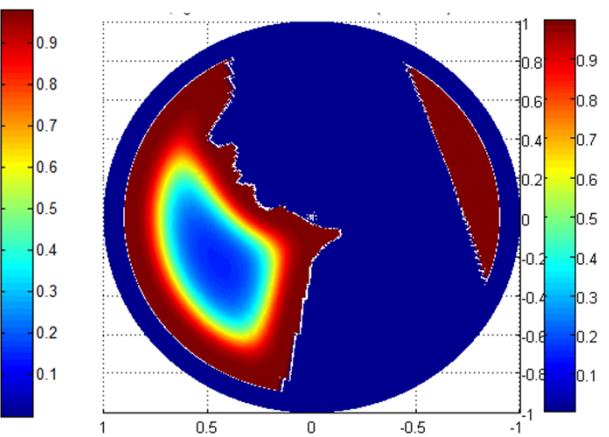


Mask

pLux/cl transfer function



B-gal behavior?



“Broken”

