

# Design of an Optical Localization and Communication Sensor for Mobile Robots

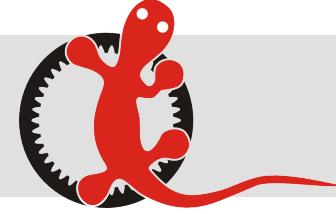
Semester Project: Midterm Presentation  
Raphael Cherney

Photograph by A. Crespi

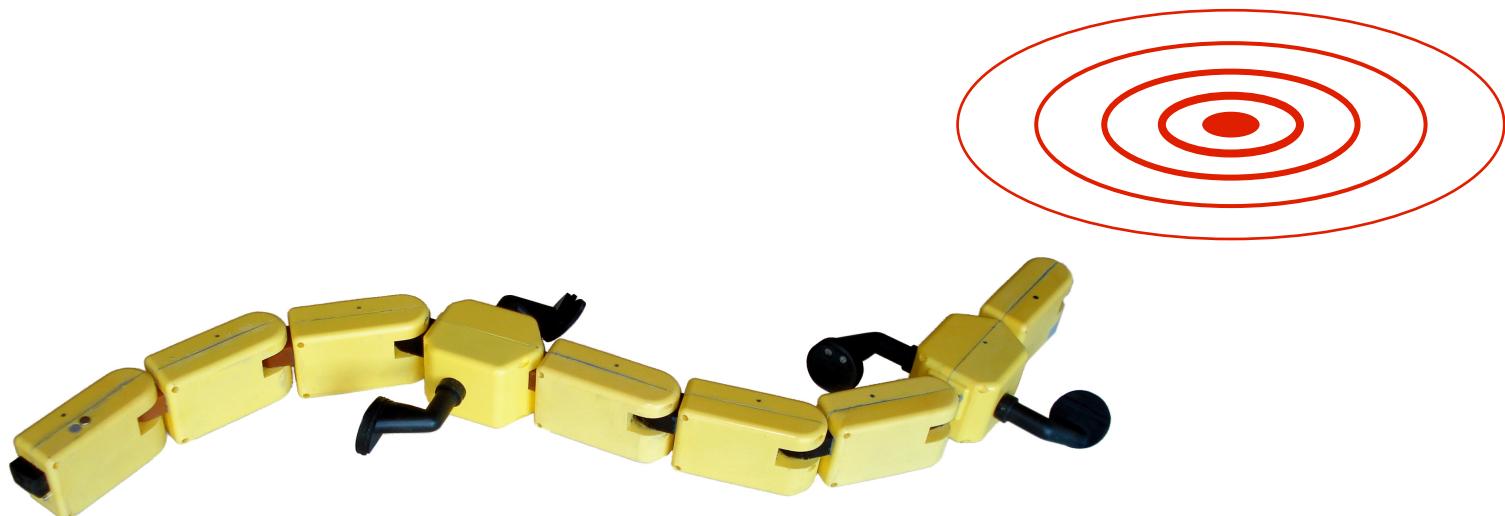


ÉCOLE POLYTECHNIQUE  
FÉDÉRALE DE LAUSANNE

# GOALS

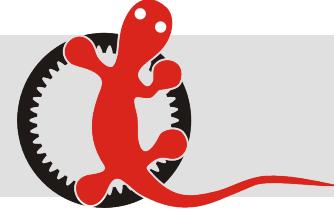


- Design a system that uses **modulated optical signals** to determine the distance and direction of a modulated transmitter
- Decode low bandwidth data sent over the optical channel (e.g. 8 bit ID)
- Study the possibility of using the same sensor for obstacle sensing (by adding some transmitter at its side)



Photograph by A. Crespi

# CONSTRAINTS

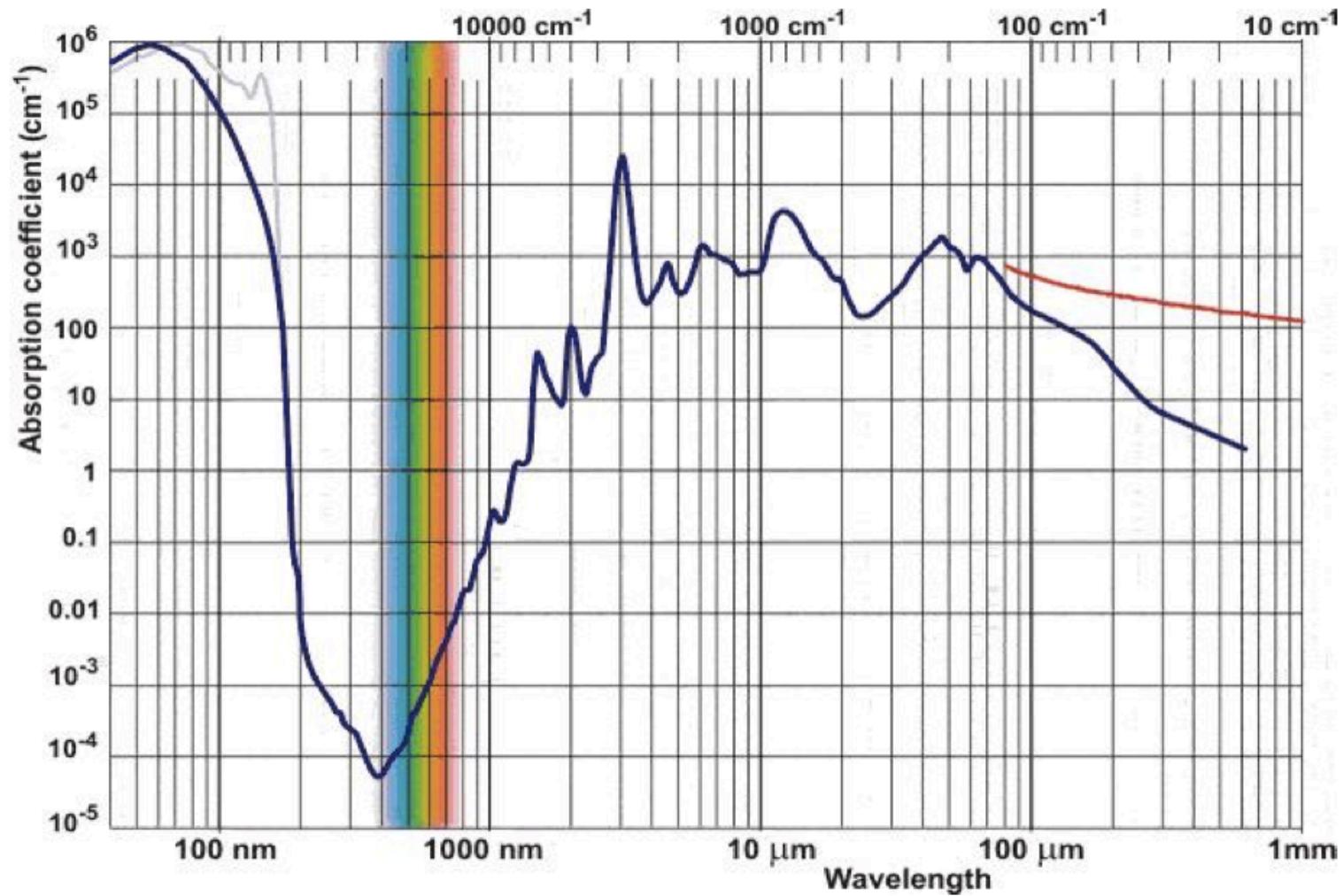
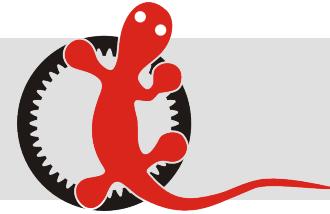


- Receiver powered by 3.3V or 5V available on robot
- Use as few components as possible
  - small space
  - lightweight
- Receiver should be waterproof
- Range of 5m in air and 1m in water (in normal light conditions)
  - study the possibility of using visible light instead of IR, for better performance in water

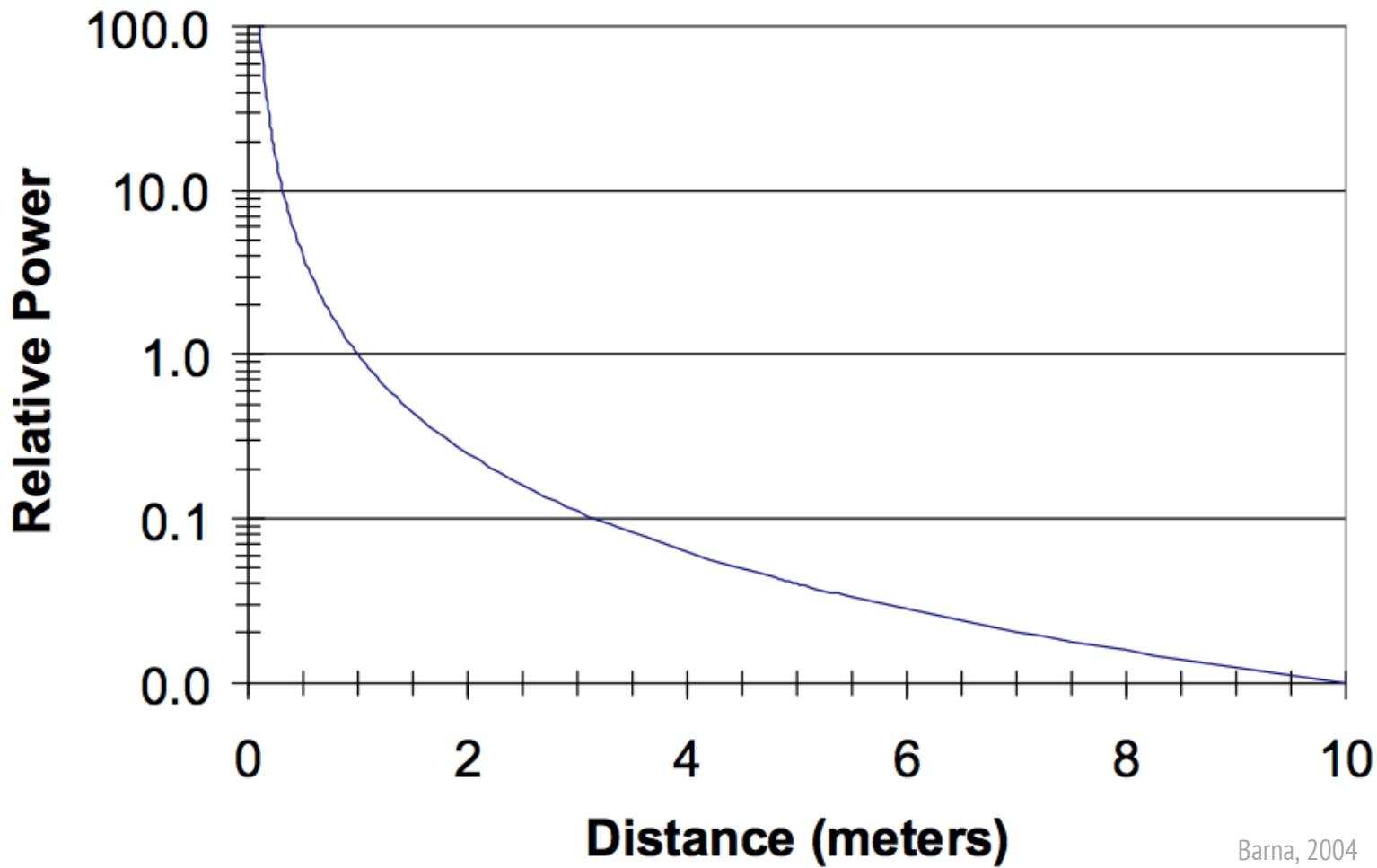
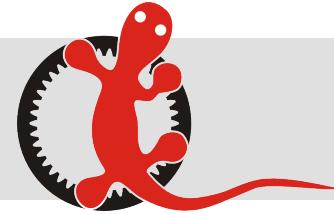


Photograph by A. Herzog

# CONSIDERATIONS

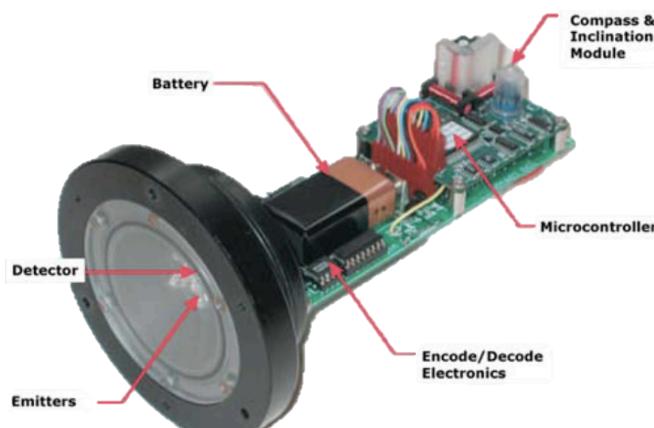
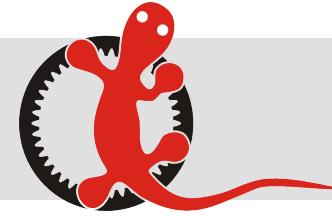


# CONSIDERATIONS

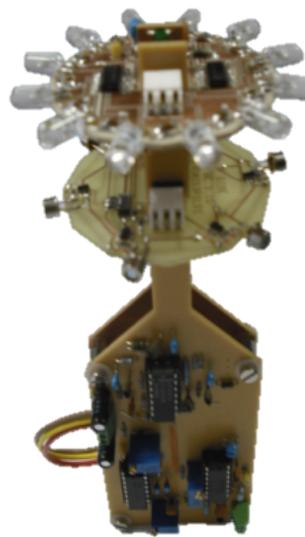


Barna, 2004

# STATE OF THE ART



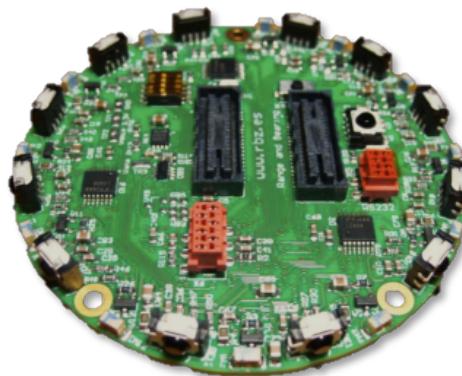
Tivey, 2004; WHOI



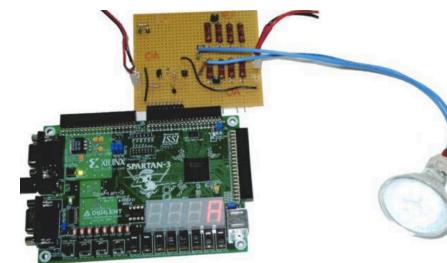
Anguita, 2010; Genova



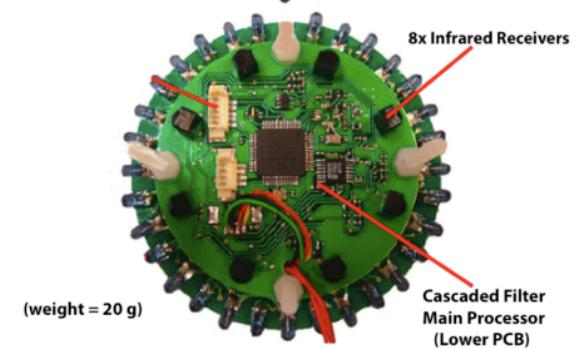
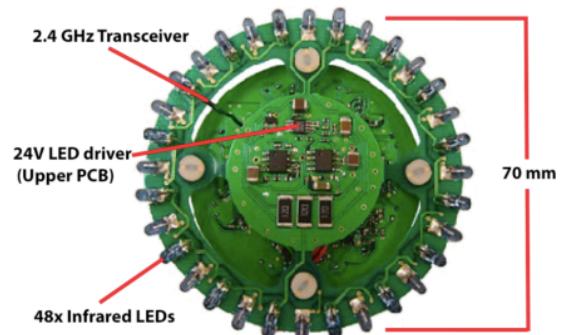
Kelly, 2004; USC



Gutiérrez, 2008; ETSI

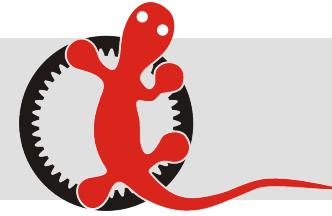


Hernandez, 2006; CEDINT

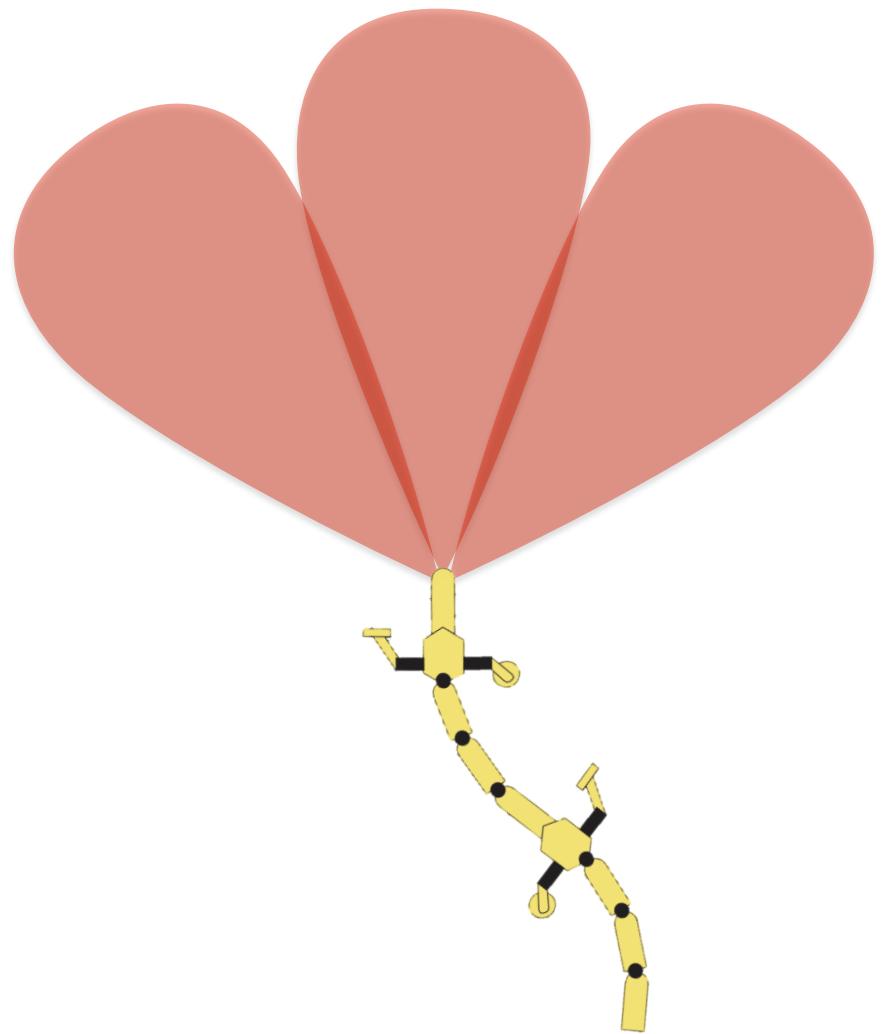


Roberts, 2009; EPFL

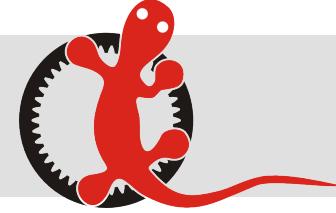
# DESIGN



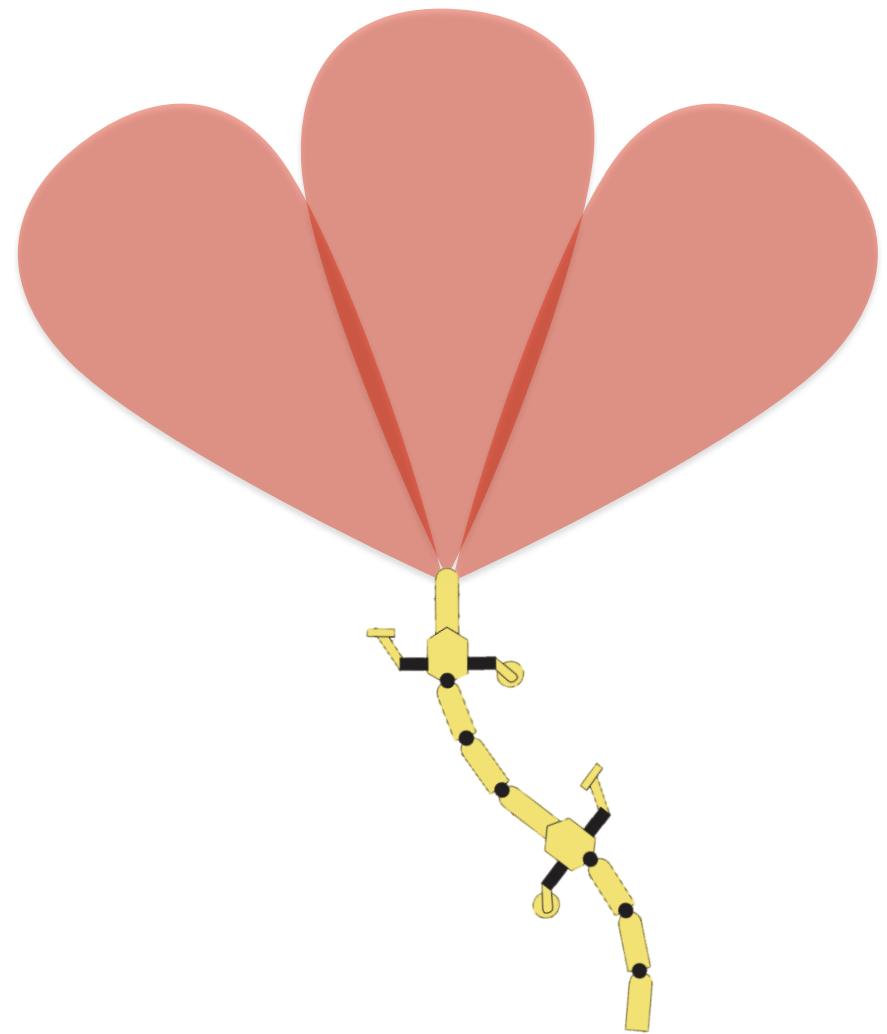
- Detector array



# DESIGN

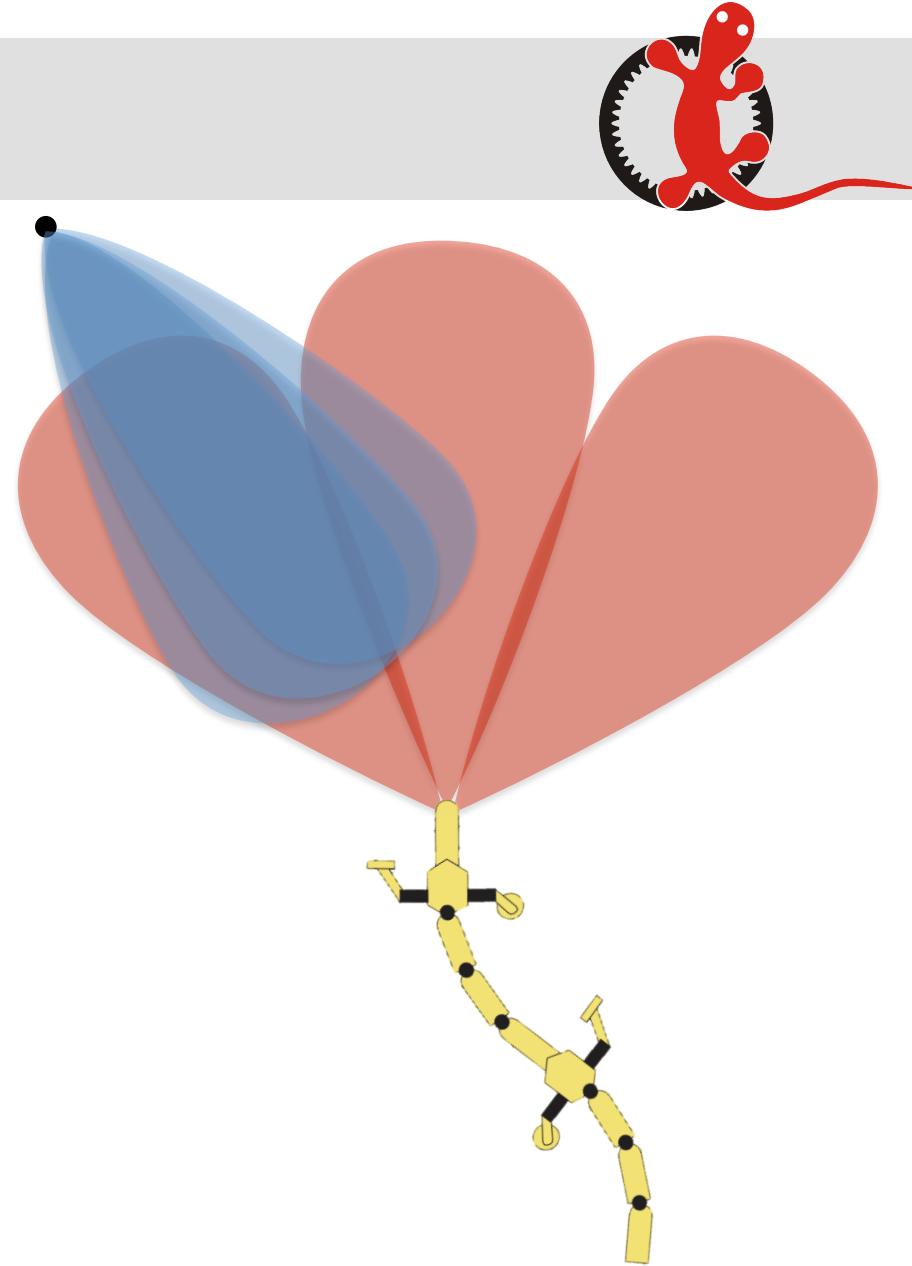


- Detector array
- Modulated signals (10 kHz carrier)

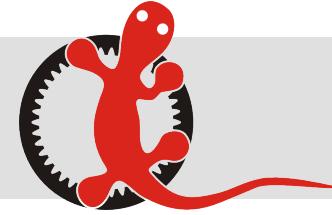


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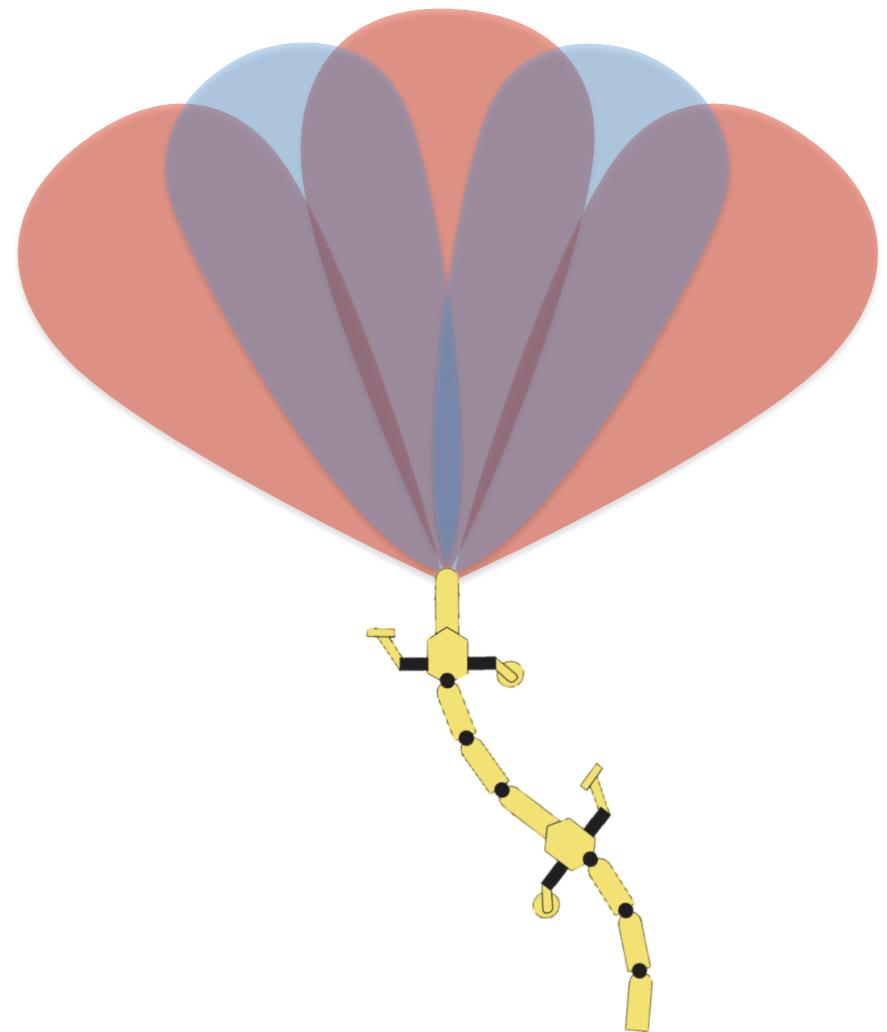
- Detector array
- Modulated signals (10 kHz carrier)
  - Active beacon



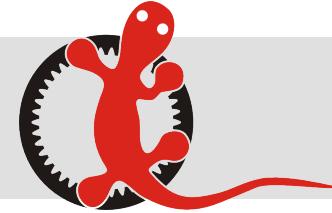
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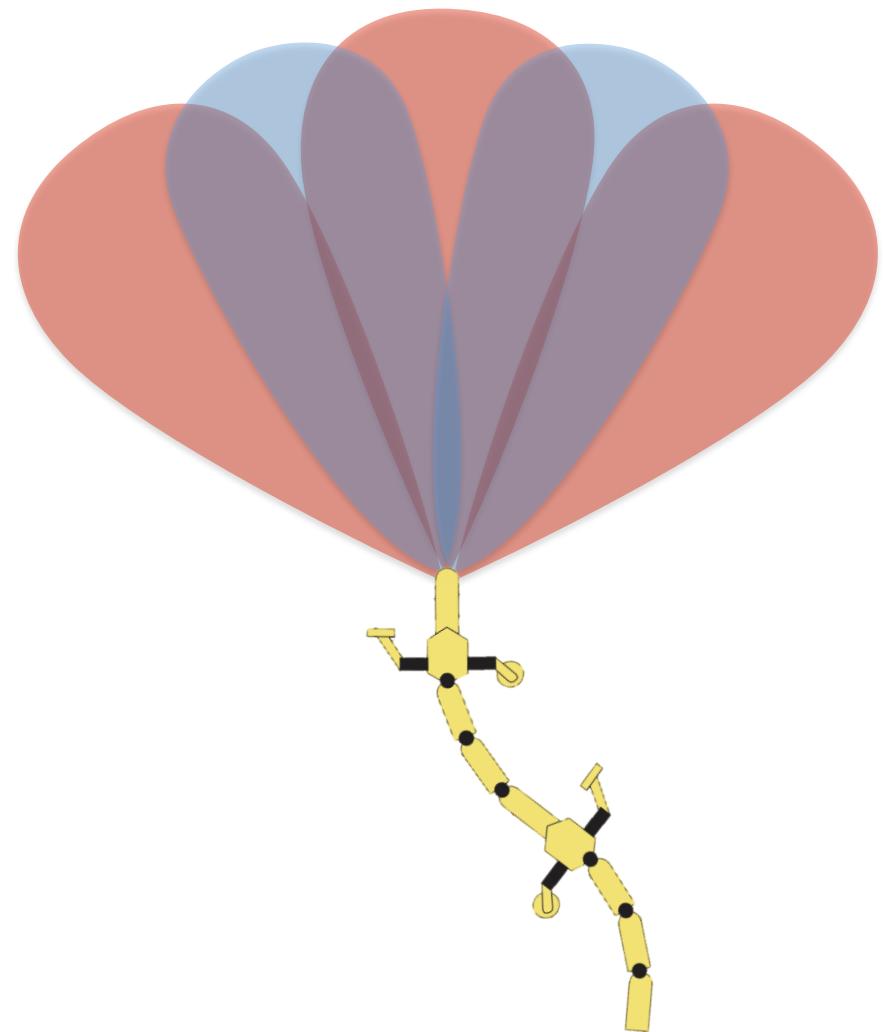
- Detector array
- Modulated signals (10 kHz carrier)
  - Active beacon
  - Onboard transmitter



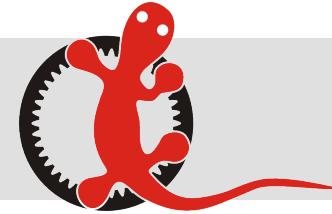
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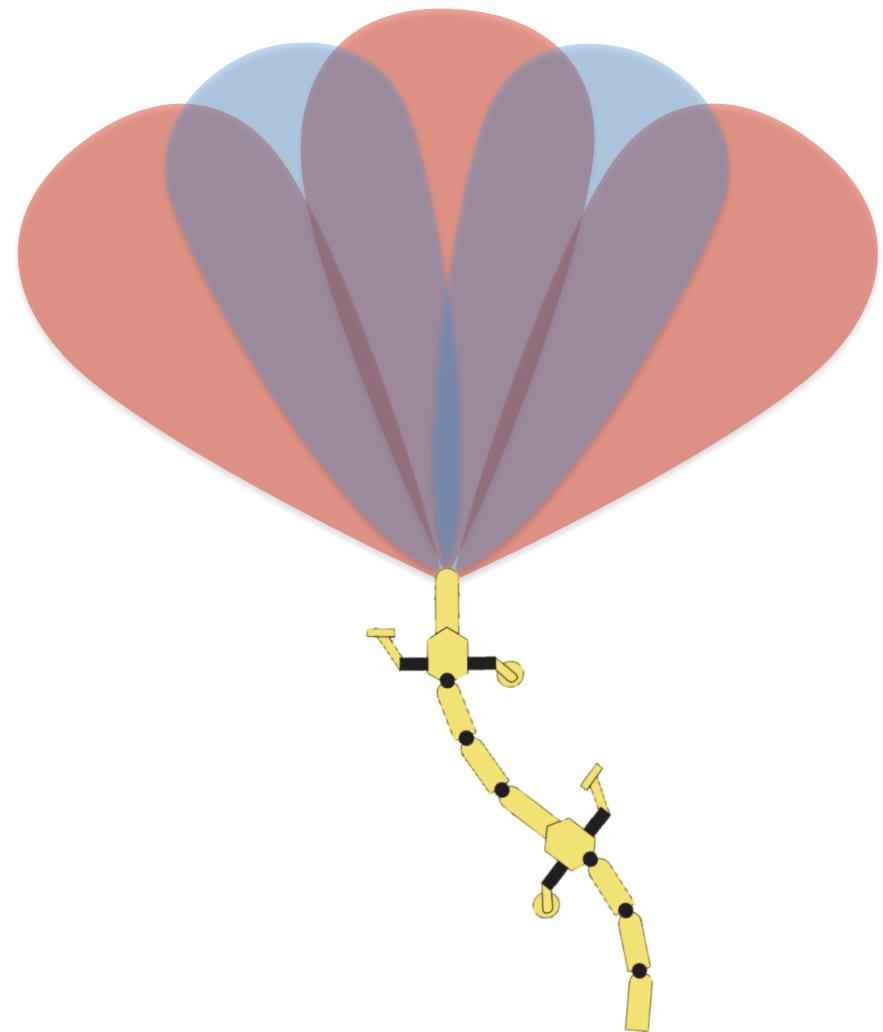
- Detector array
- Modulated signals (10 kHz carrier)
  - Active beacon
  - Onboard transmitter
- Transmit data over optical channel (PWM, PPM, OOK)



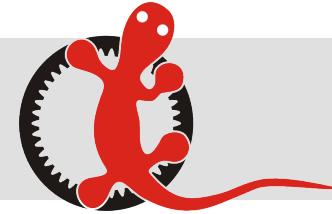
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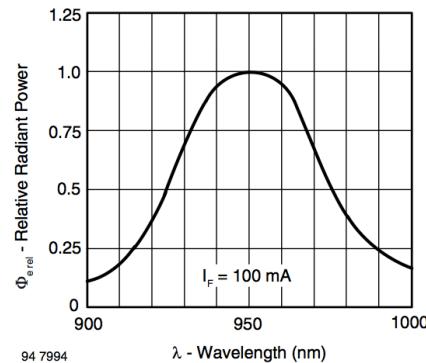
- Detector array
- Modulated signals (10 kHz carrier)
  - Active beacon
  - Onboard transmitter
- Transmit data over optical channel (PWM, PPM, OOK)
- Works with visible or infrared light



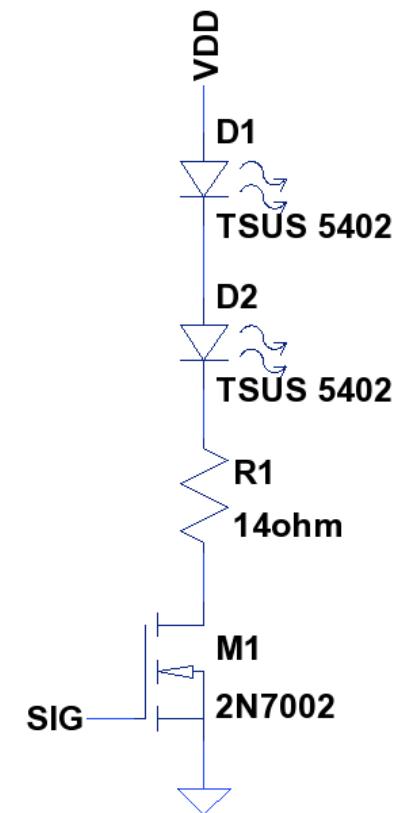
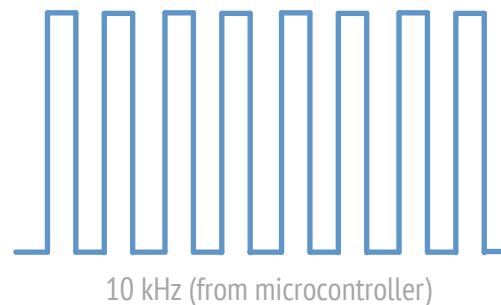
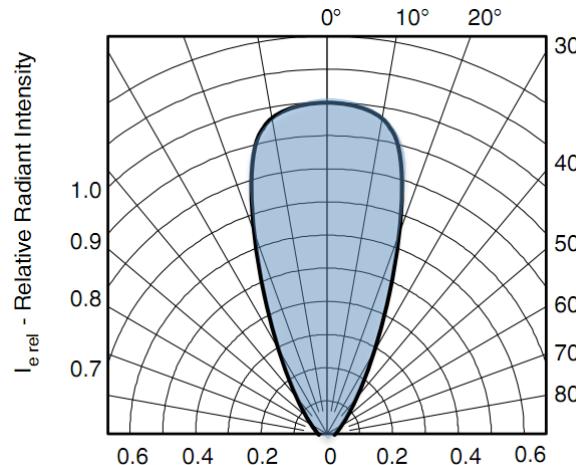
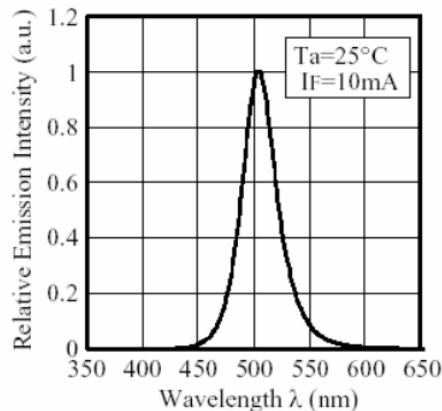
# TRANSMITTER



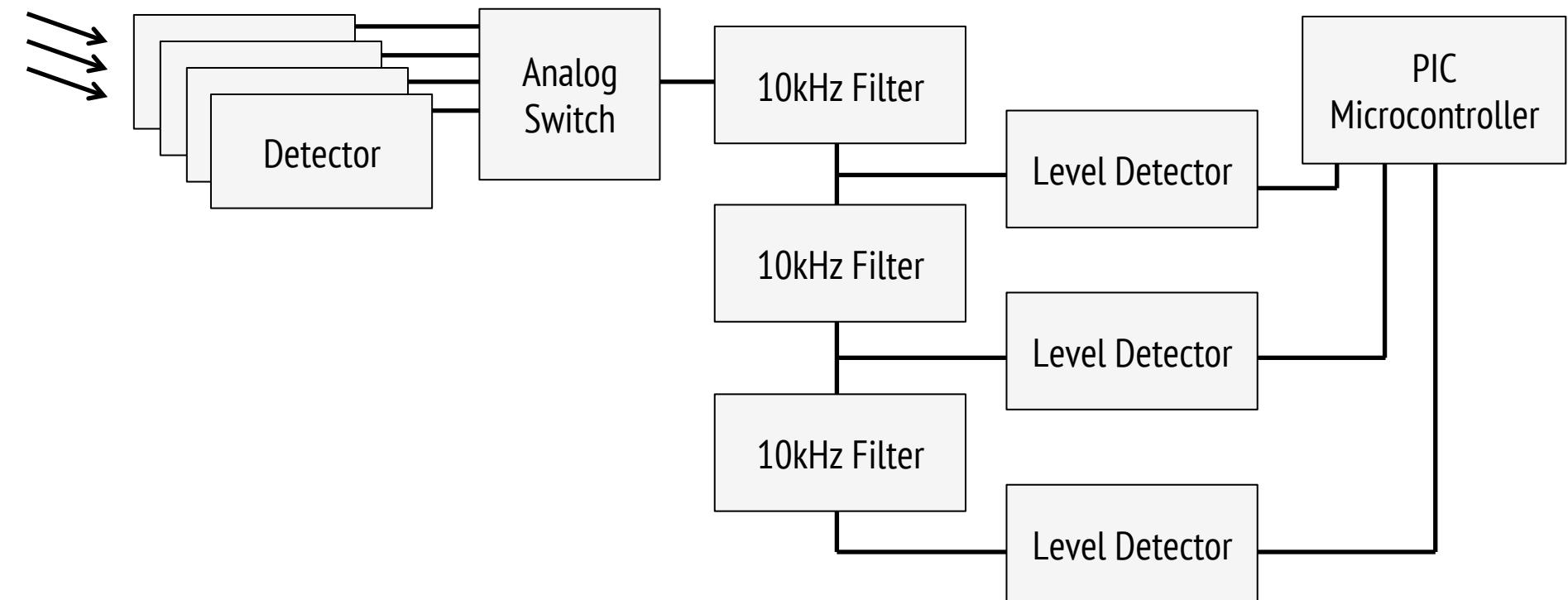
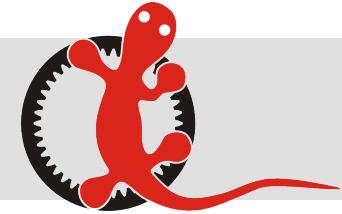
- Modulated 10 kHz carrier
- Infrared source: TSUS 5402



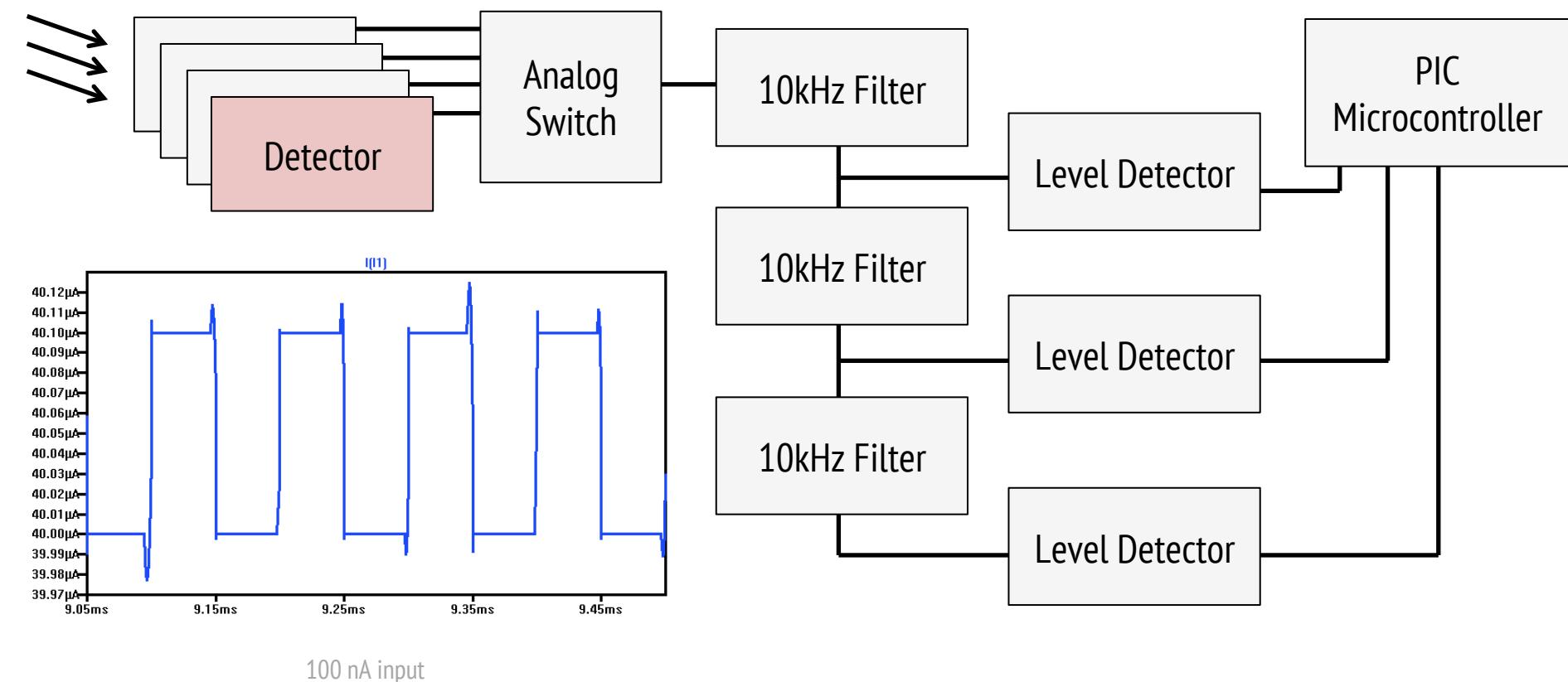
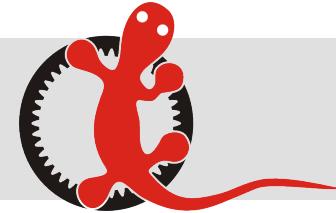
- Cyan light source: L5-BG1G



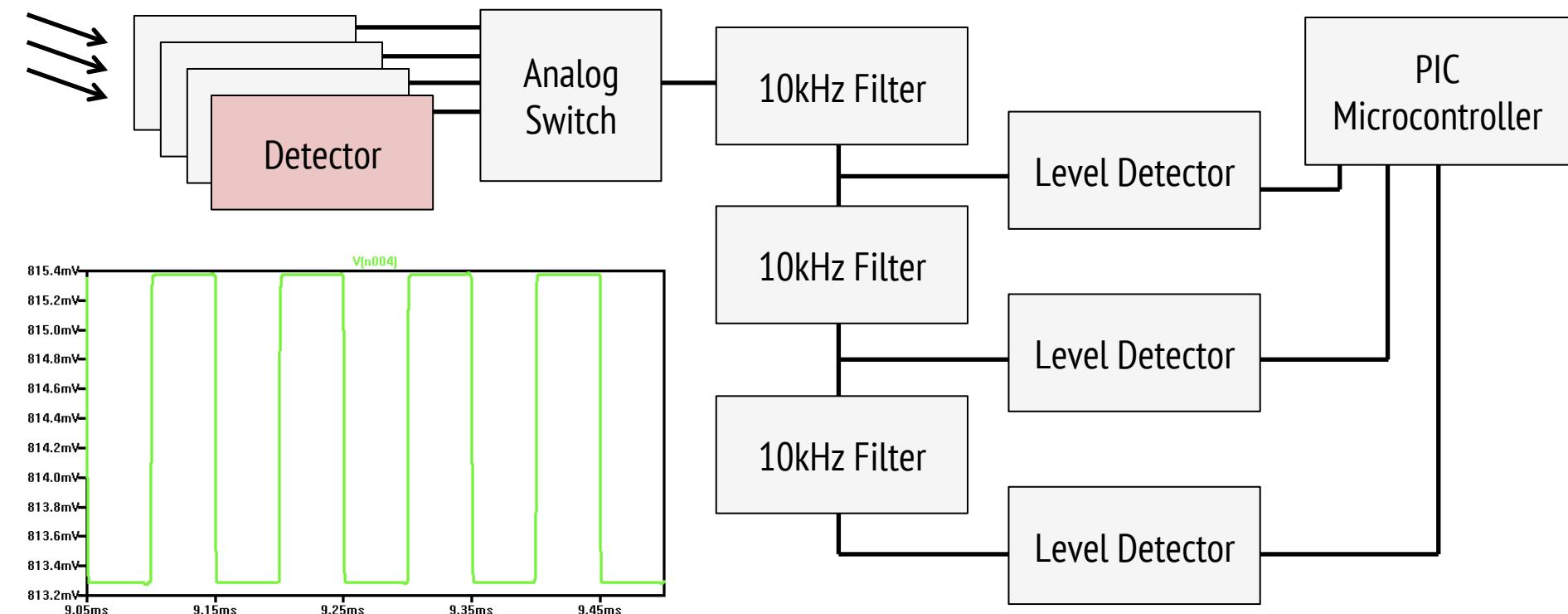
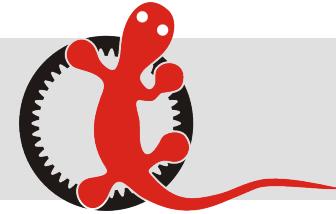
# RECIEVER



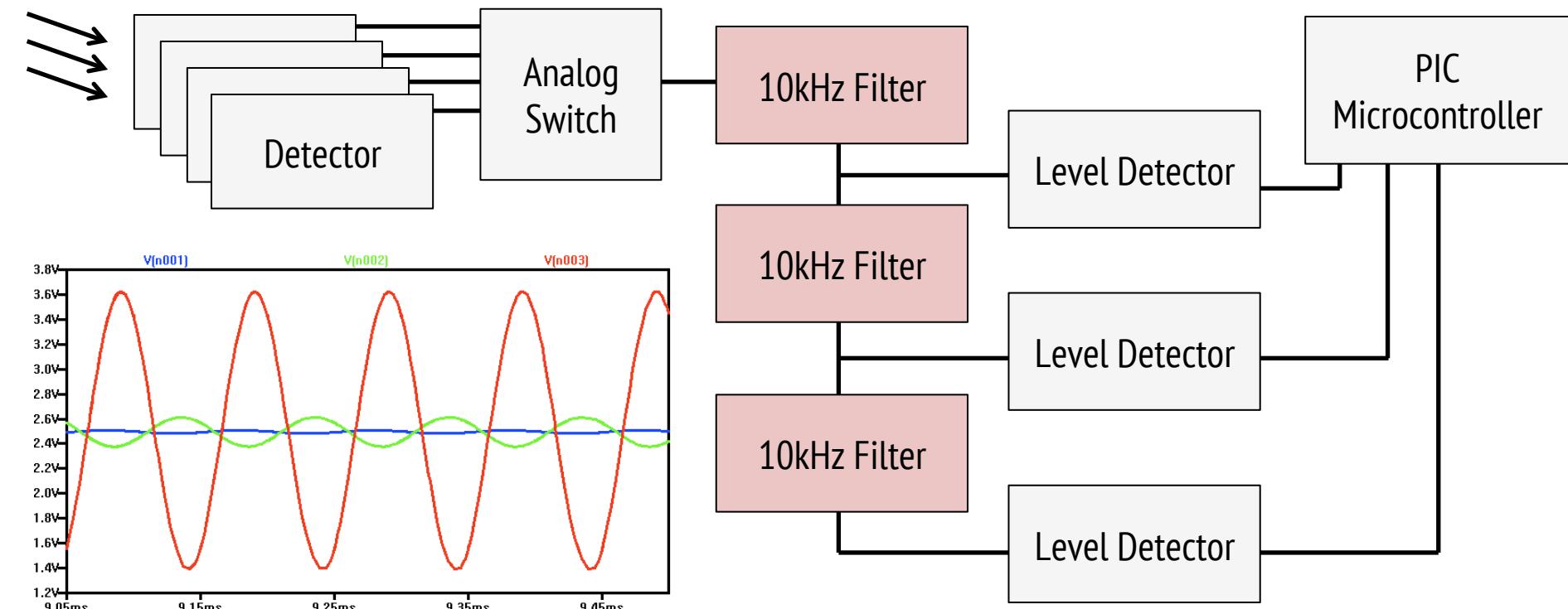
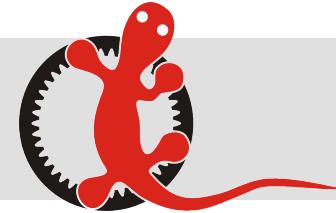
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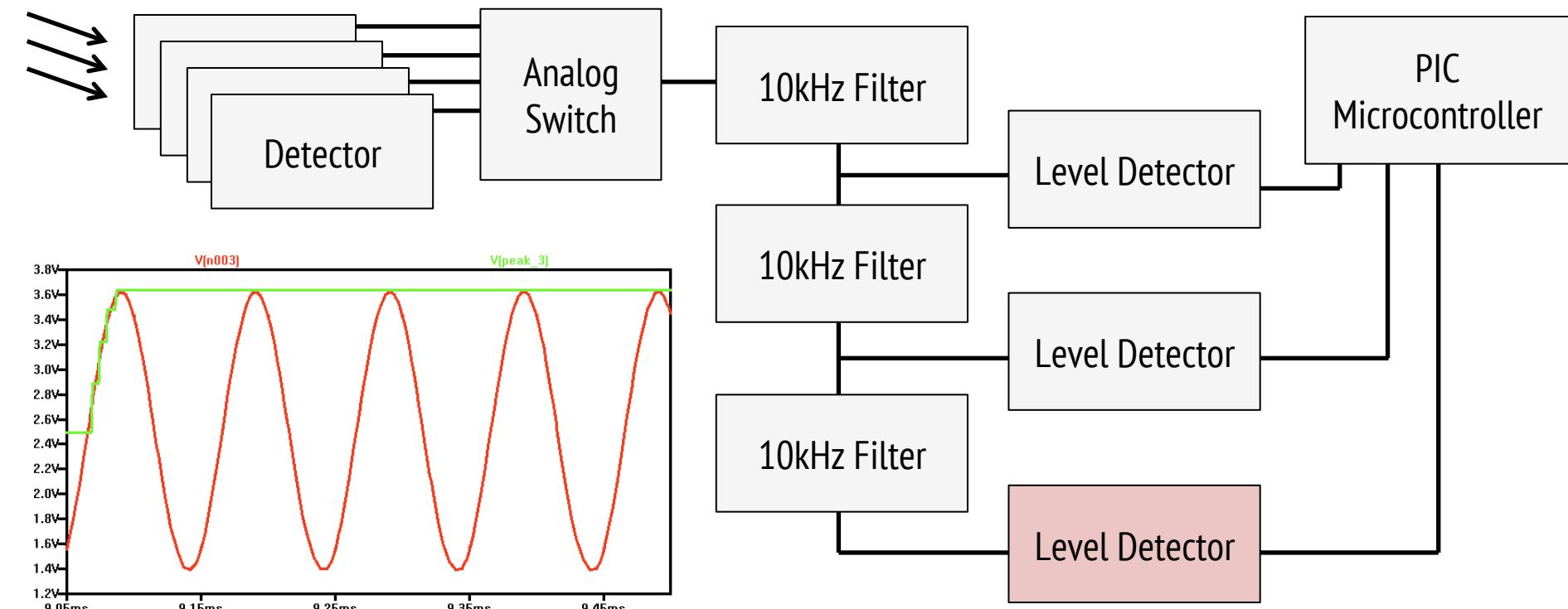
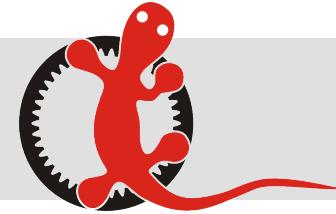
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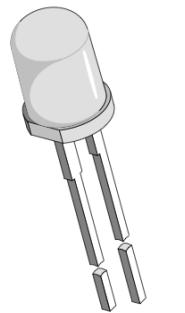
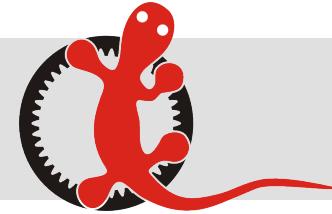
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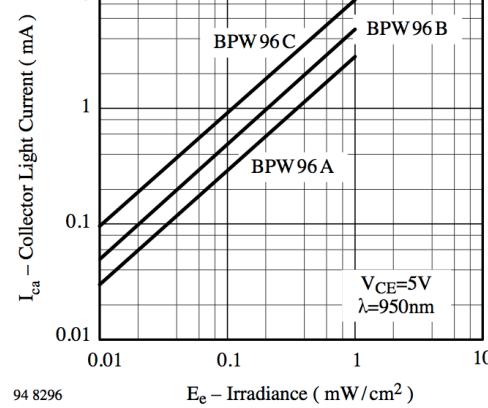
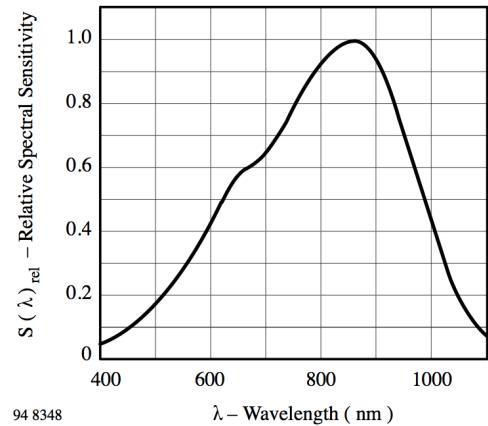
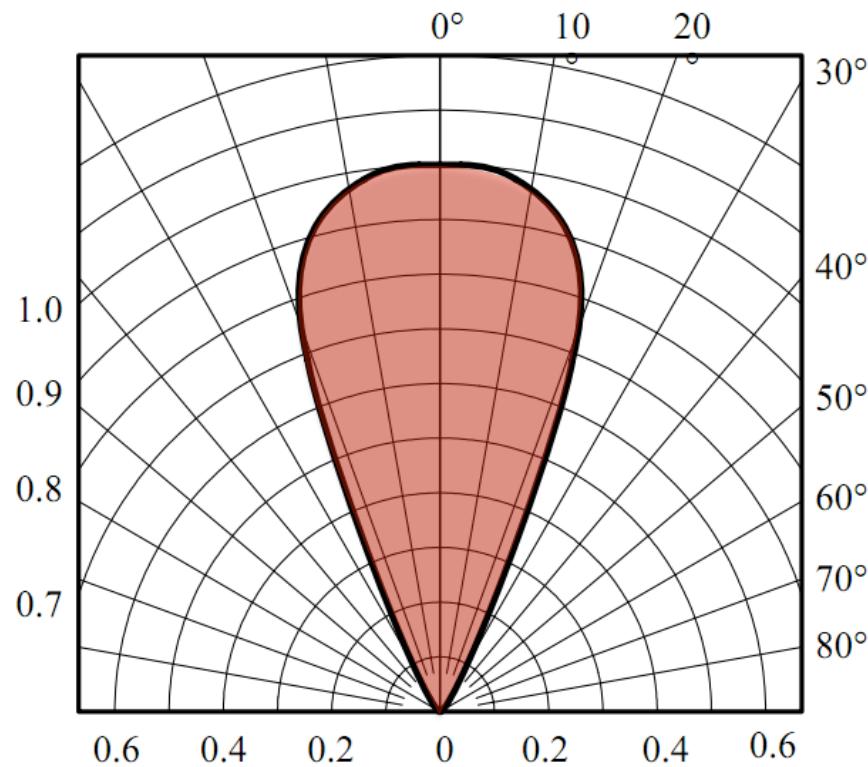
# RECIEVER



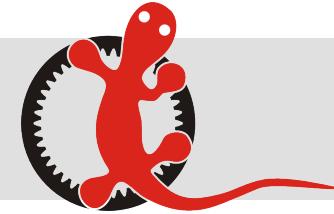
# DETECTOR



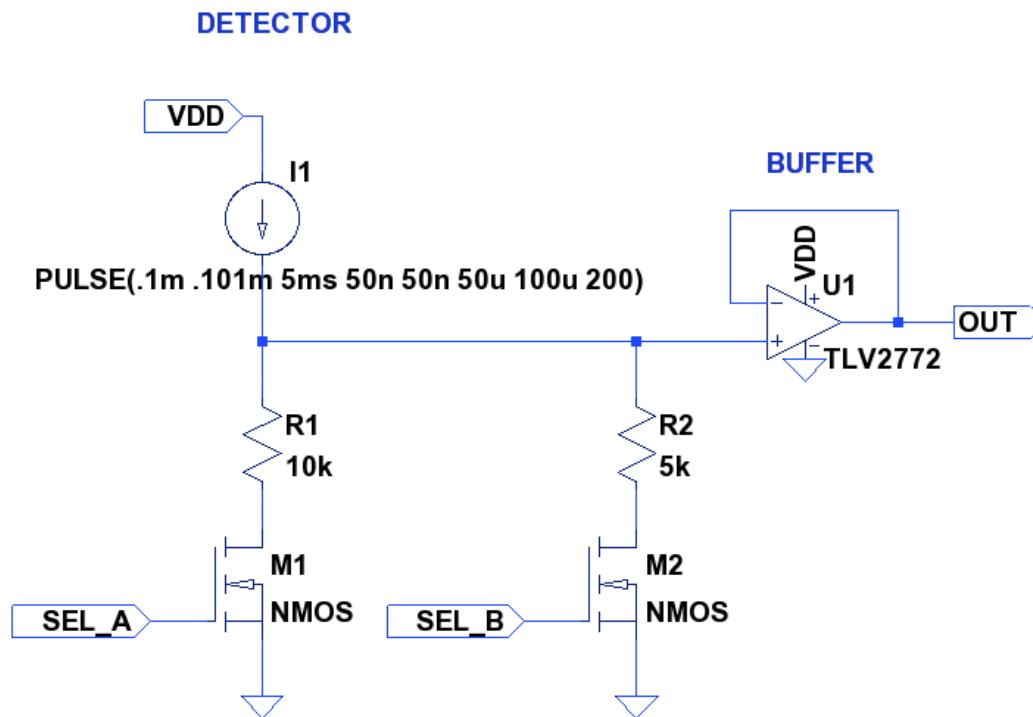
S<sub>rel</sub> – Relative Sensitivity



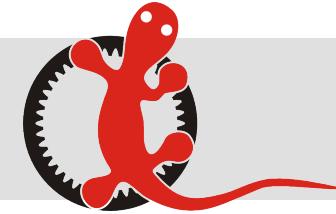
# DETECTOR



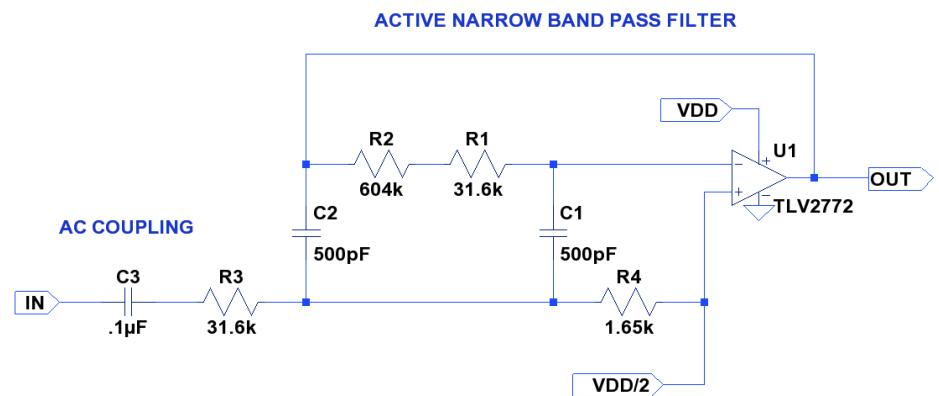
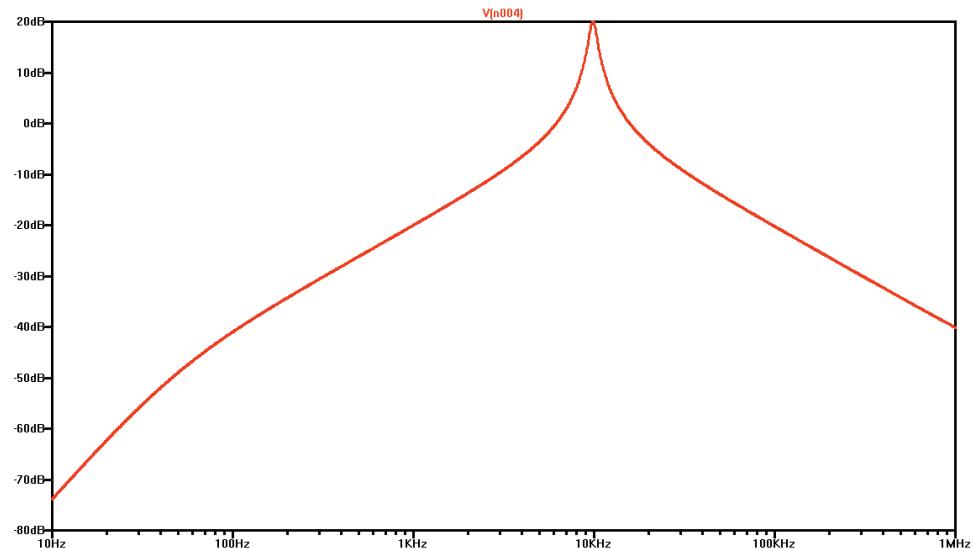
- Adjustable for different light conditions/sensitivity



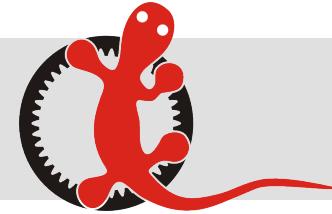
# FILTERS



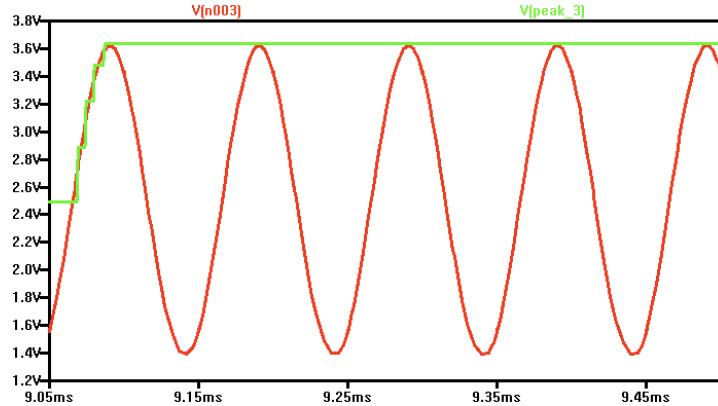
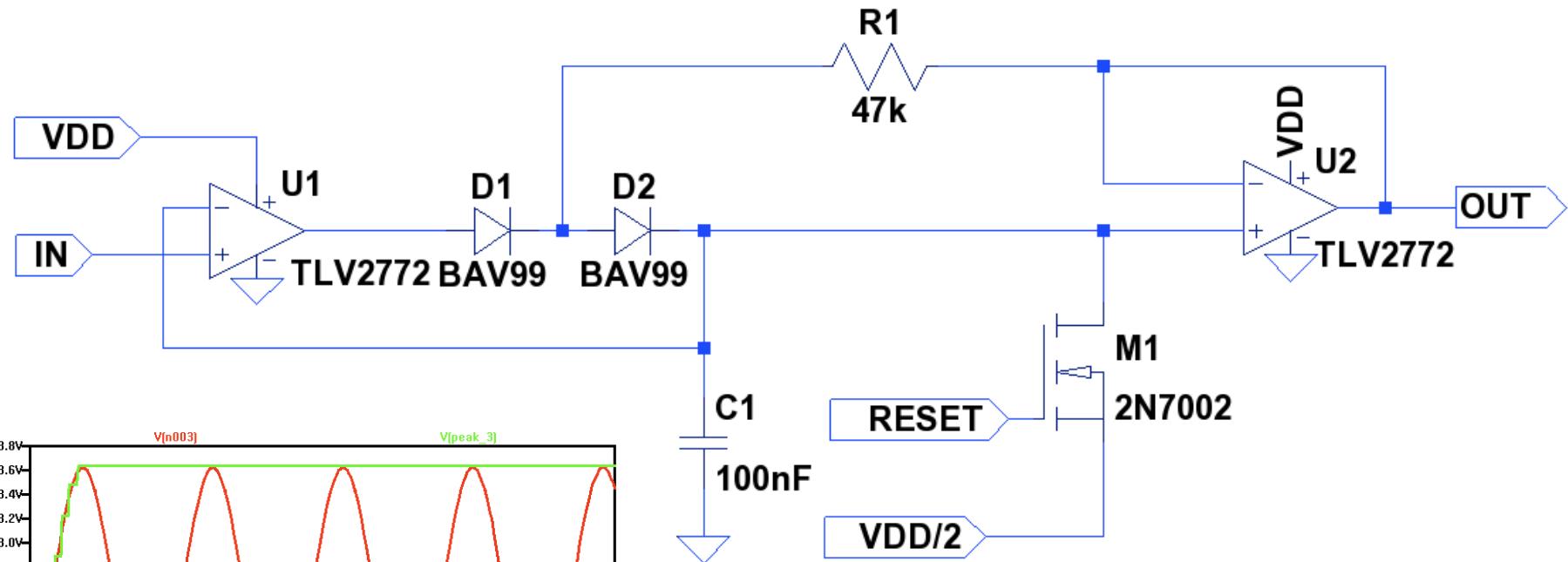
- Active, narrow band pass filters
  - modified Deliyannis filter
- Gain of 10 for selected frequency
- 3 cascaded stages
  - read signal strength from appropriate stage



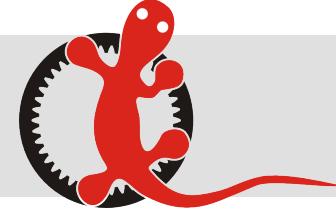
# LEVEL DETECTOR



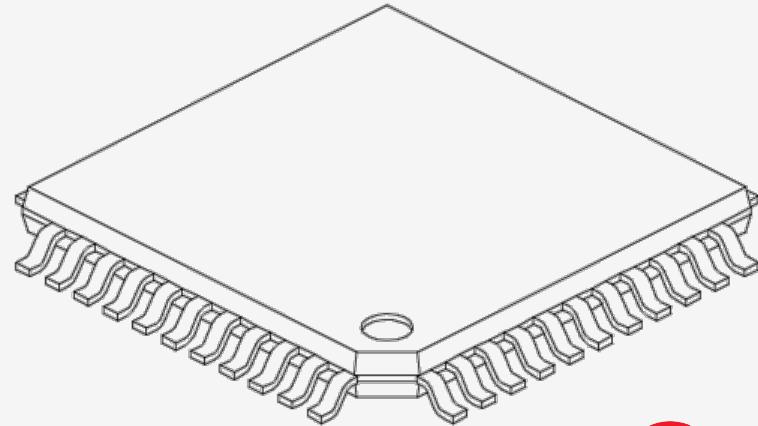
## PEAK DETECTOR



# MICROCONTROLLER

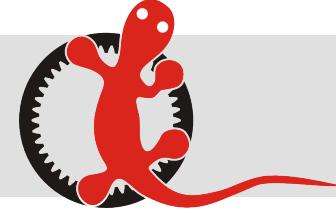


- Control low-level signals
- Analog-to-digital conversion
- Data processing
- Interface with robot



- PIC18F2580
  - 10 MIPS
  - 32 KB program memory
  - 100 ksps 10-bit ADC

# NEXT STEPS



- Manufacture printed circuit board
- Program sensor firmware
- Calibration
- Testing
- Demo with salamander (head following an active sender)



# QUESTIONS

