# MICRO-523: Optical Detectors

## Week Two: Optical Methods – Selected Examples - Solutions

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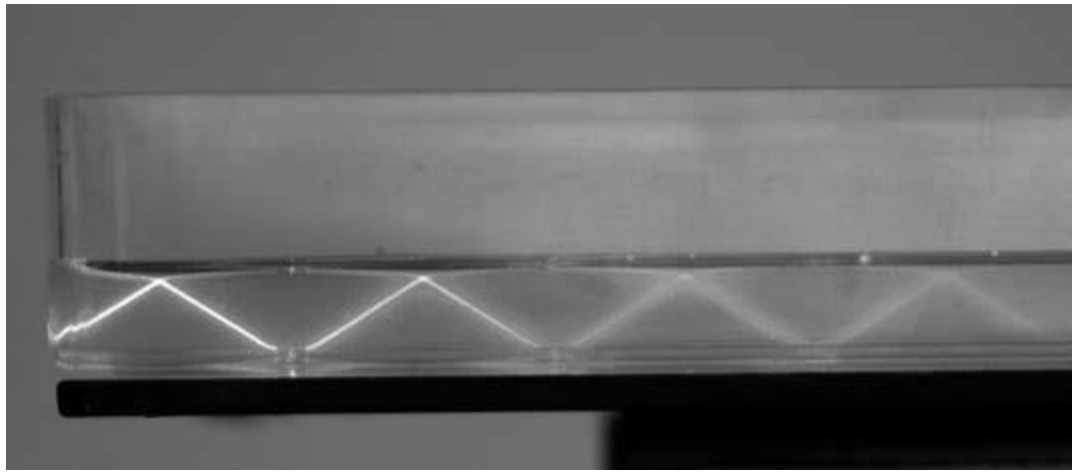
Based on MICRO-523, P.-A. Besse, 2023

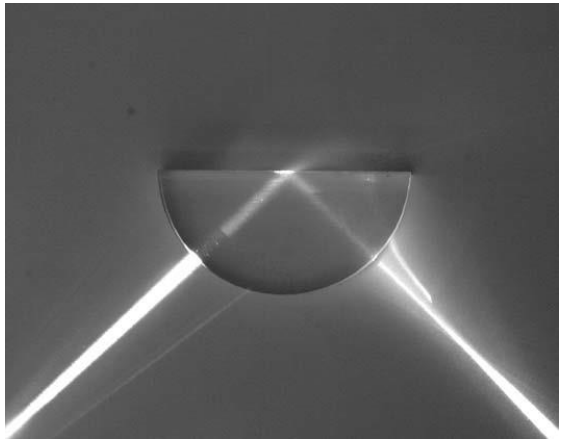
TAs: Samuele Bisi, Kodai Kaneyatsu

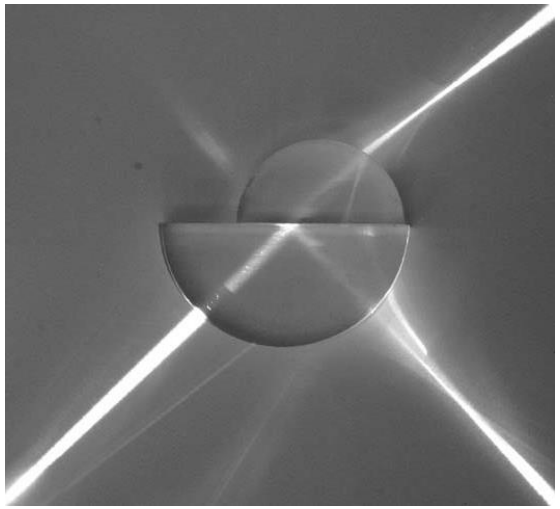
# Homework 1: Rain Sensor

Design a rain sensor for a car windshield based on these experiments.



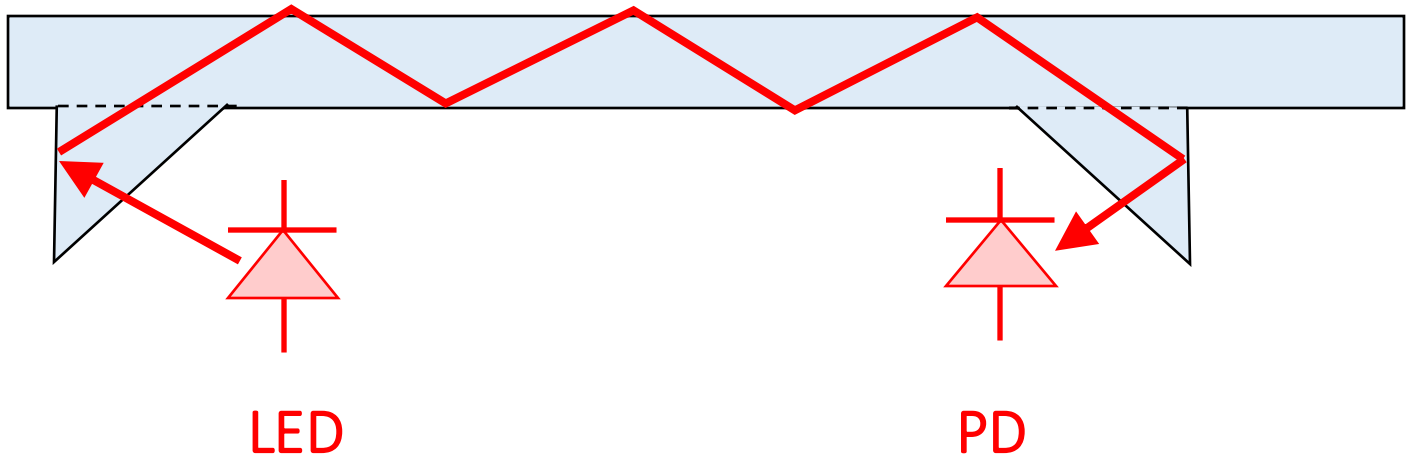
Thomas Geßner, Thomas Wilhelm
«Der Regensensor im Unterricht»





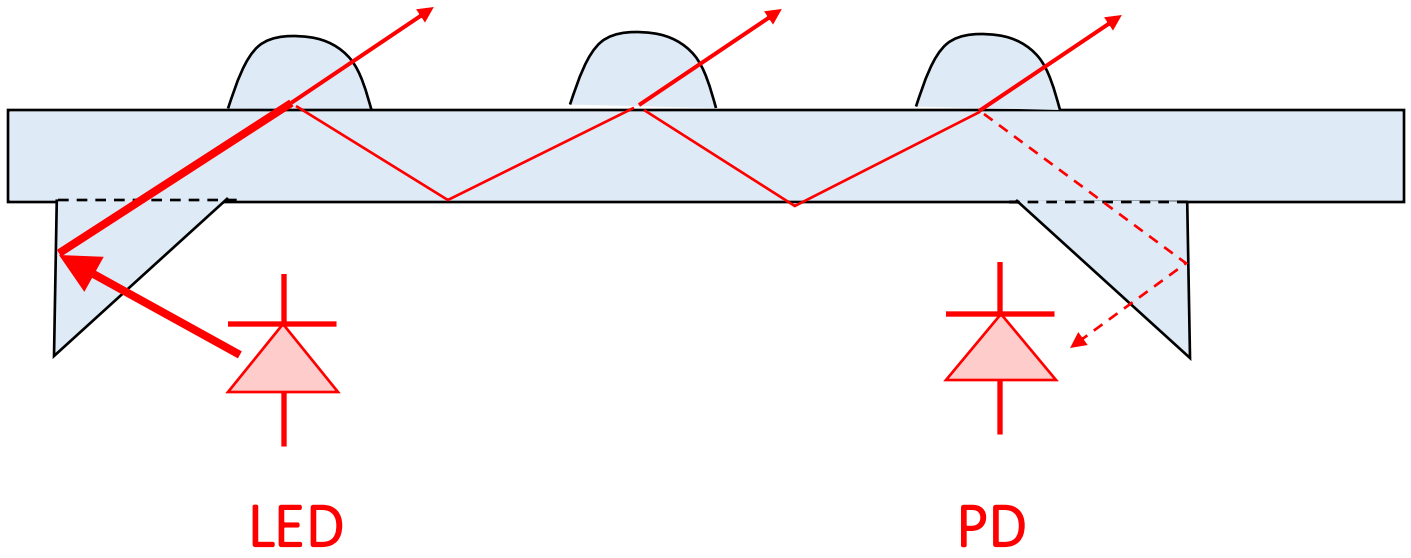
# Homework 1 : Rain Sensor

Total internal reflection in the absence of water



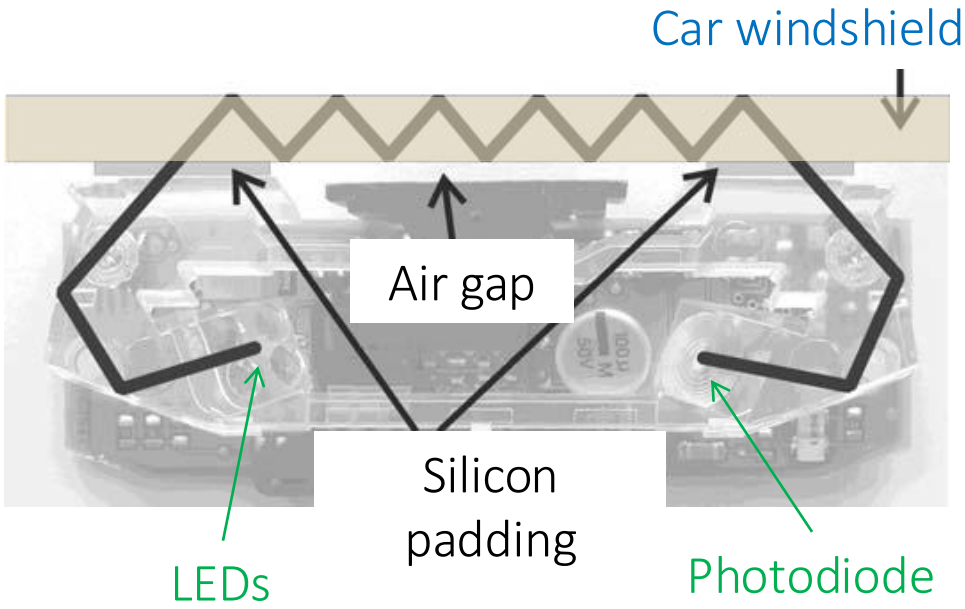
# Homework 1 : Rain Sensor

Light transmit partially to the water drops

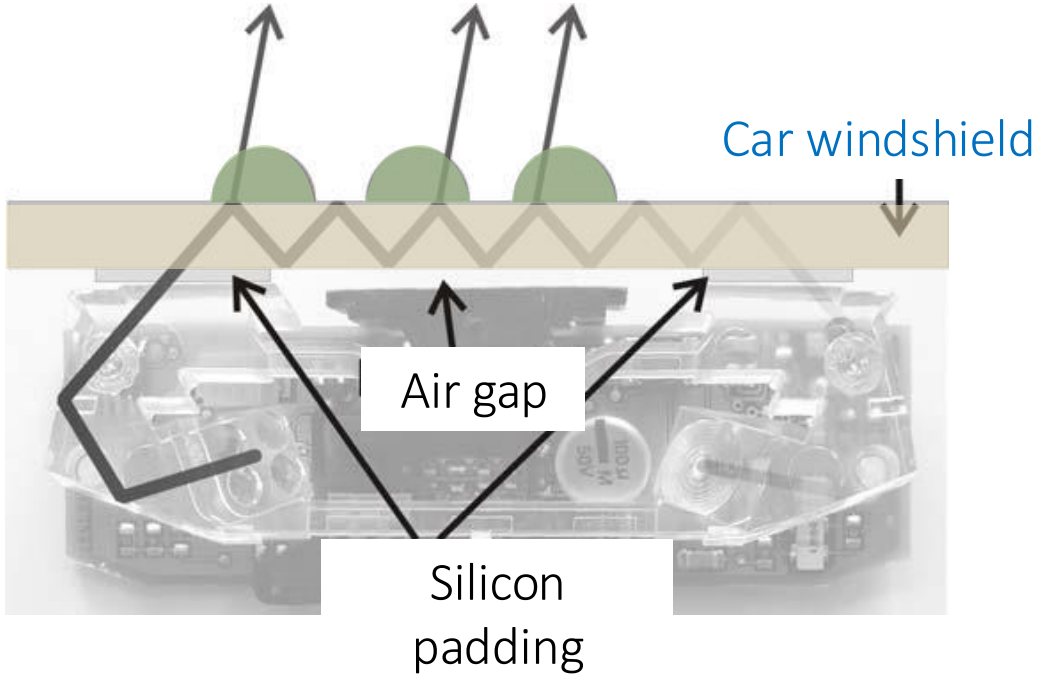


# Homework 1 : Rain Sensor

**Dry windshield**



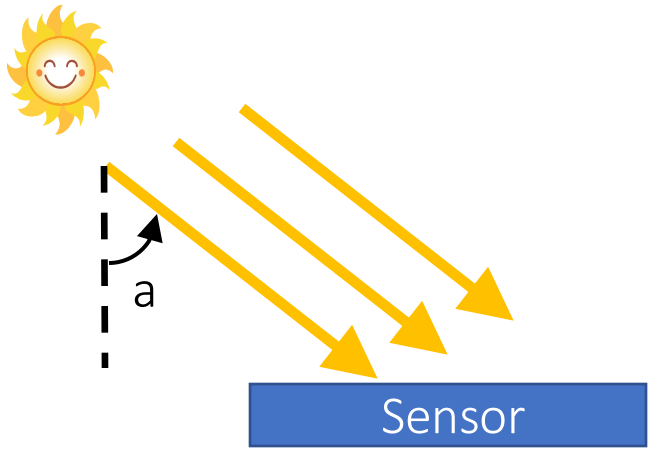

**Rain**




→ Activate the windshield wipers

Thomas Geßner, Thomas Wilhelm «Der Regensensor im Unterricht»

# Homework 2: Sun Sensor

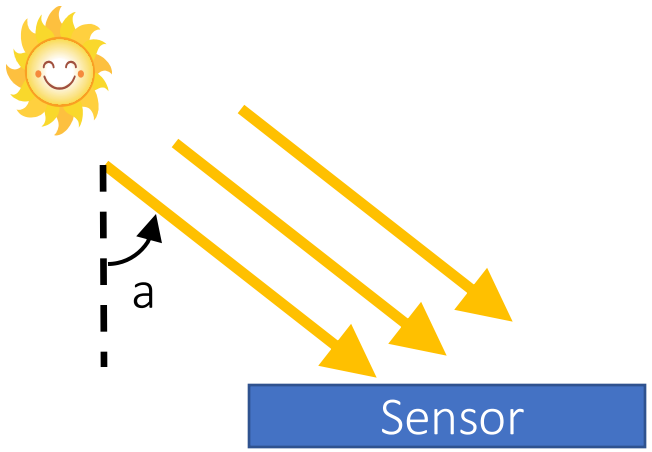


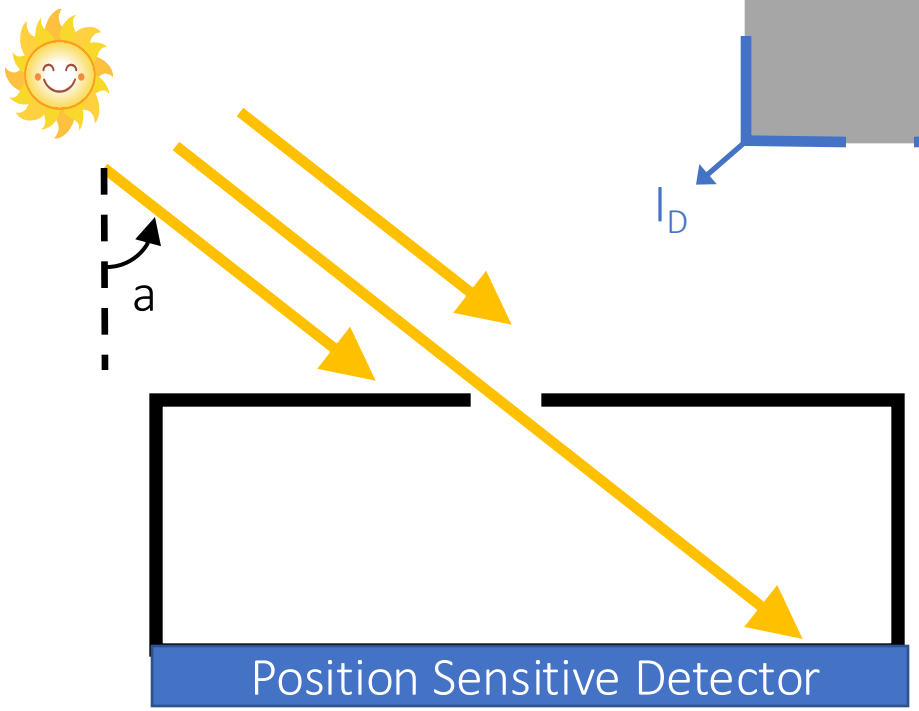

Design a sensor to measure the azimuth and the elevation of the sun!

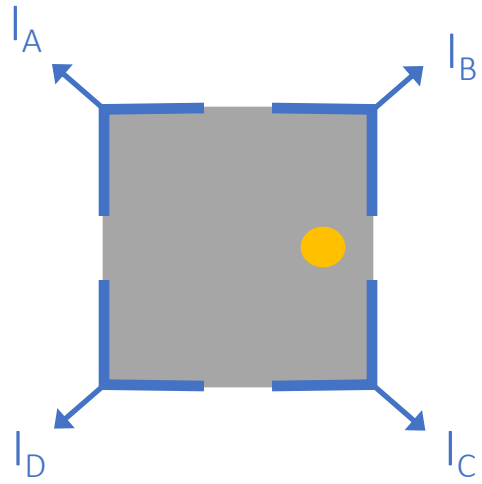
A possible application could be to guide a satellite.

1) Location sensor:
   - S.W. Janson «micro/nanotechnology for picosatellites», 22nd Annual AIAA/USU Conference on small satellites, paper SSC08-VII-6
2) Camera:
   - N. Xie, A. Theuwissen, «Low-power high-accuracy micro-digital sun sensor by means of a CMOS image sensor», Journal of Electronic Imaging 22(3), 033030 (Jul–Sep 2013)

# Homework 2: Sun Sensor



# Homework 2: Sun Sensor

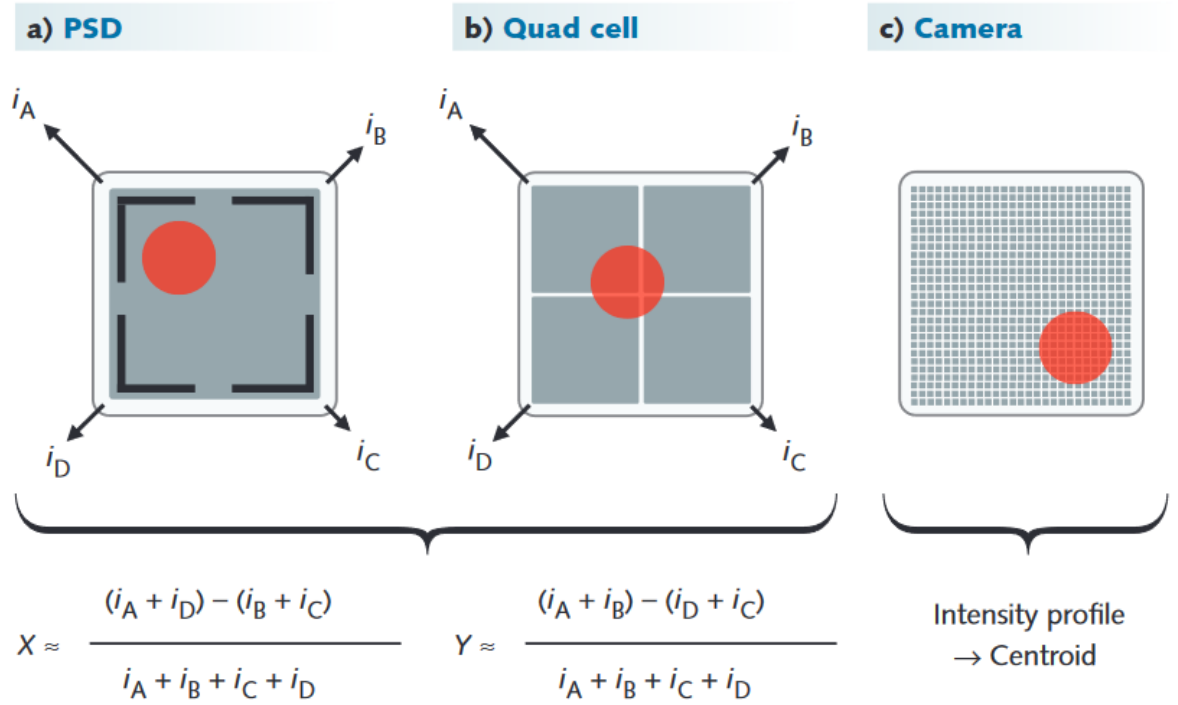
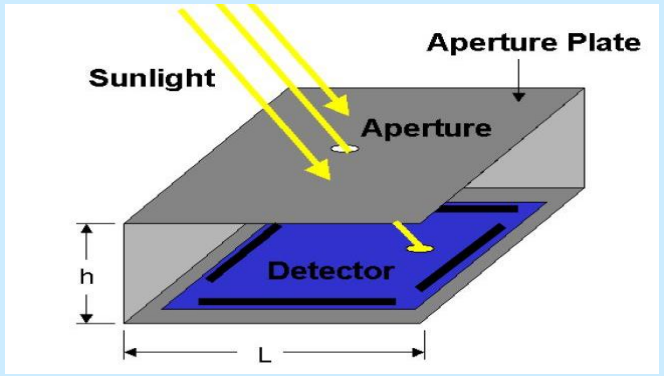
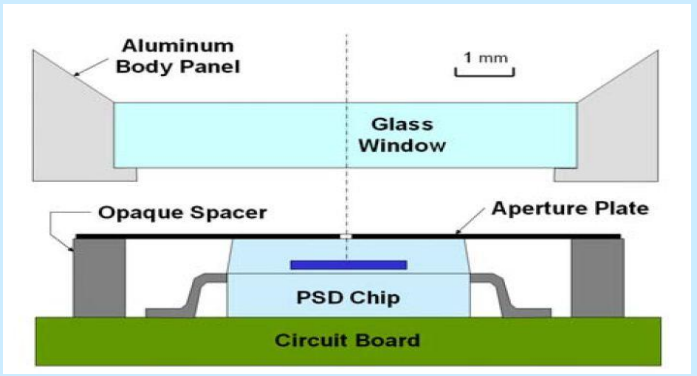



**FIGURE 1.** Devices for detecting the position of a laser beam include: a) a position-sensitive detector (PSD), b) a quadrant-cell detector (quad cell), and c) a CMOS camera. The *X* and *Y* beam position on both the PSD and quad cell can be calculated from the detectors' current outputs $i_A$, $i_B$, $i_C$, and $i_D$. The beam position on the camera is determined by finding the beam's centroid.

A. Cordes, A. Davidson "Detectors: CMOS cameras allow robust active stabilization of laser beams", Laser focus world, 2011

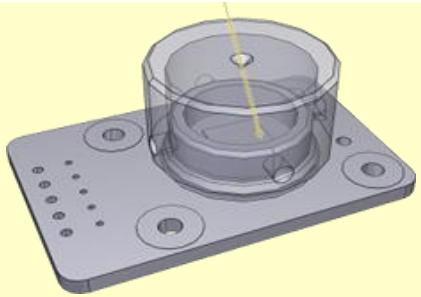
# Homework 2: Sun Sensor

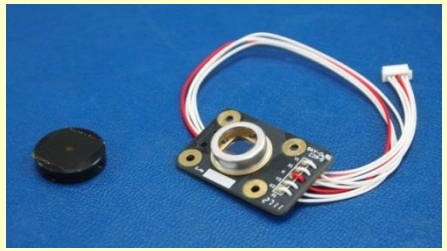



S.W. Janson «micro/nanotechnology for picosatellites», 22nd Annual AIAA/USU Conference on small satellites, paper SSC08-VII-6

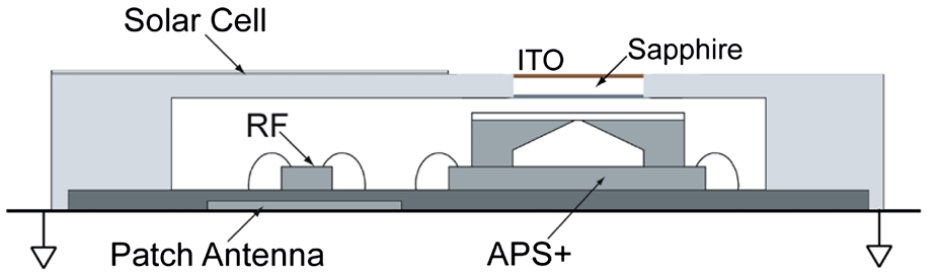
http://www.kiwisat.org.nz/sun_sensor.html

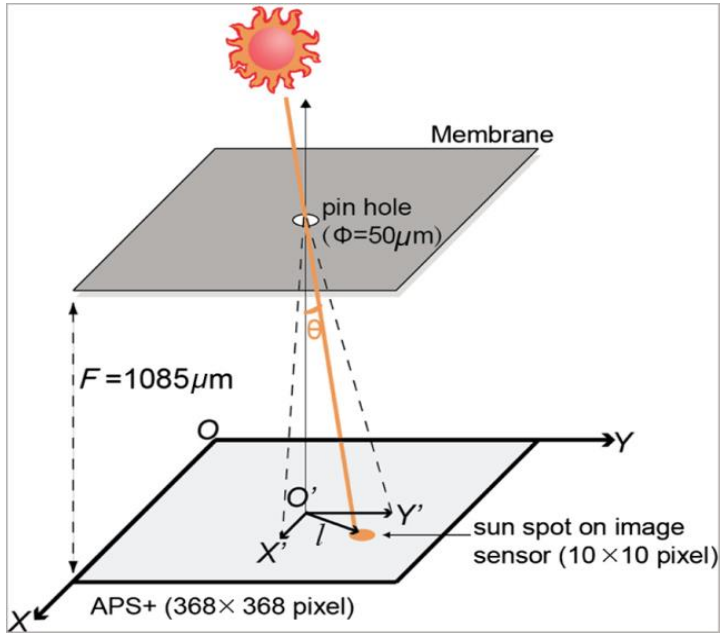


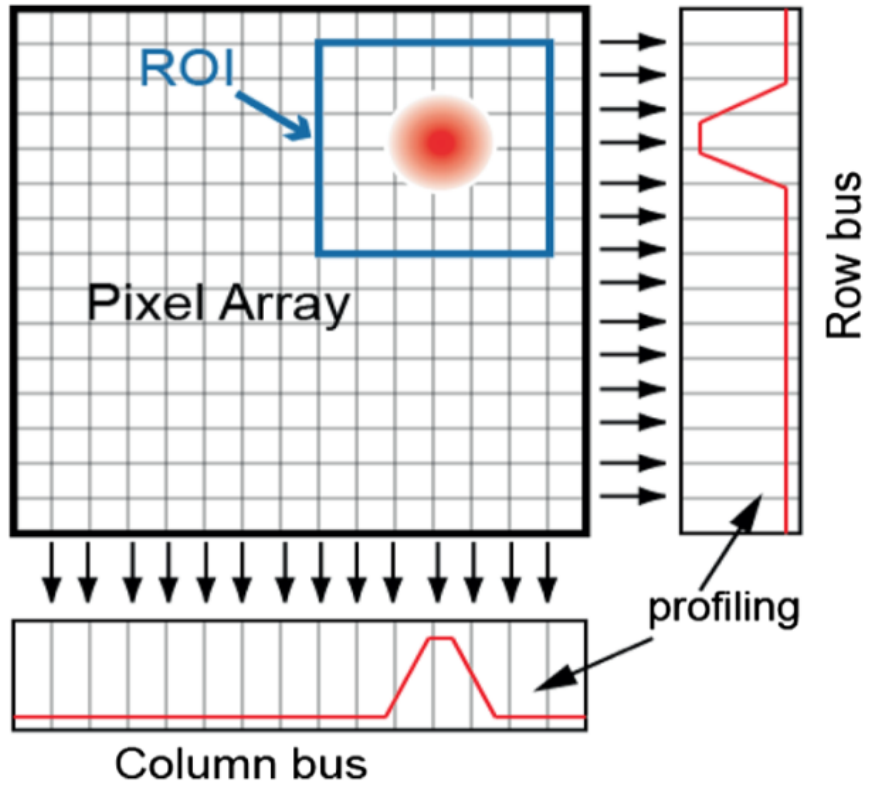


http://hakenberg.de/automation/sunsensor.htm

# Homework 2: Low-Power Camera

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