IR Imaging

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April 10, 2026

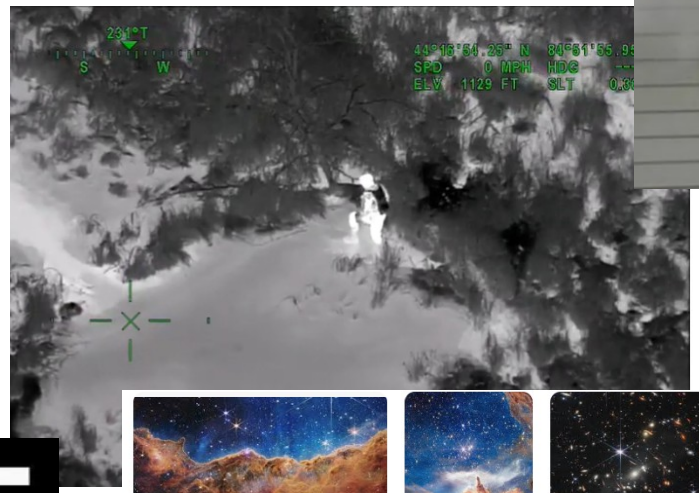
Why IR Imaging is Useful

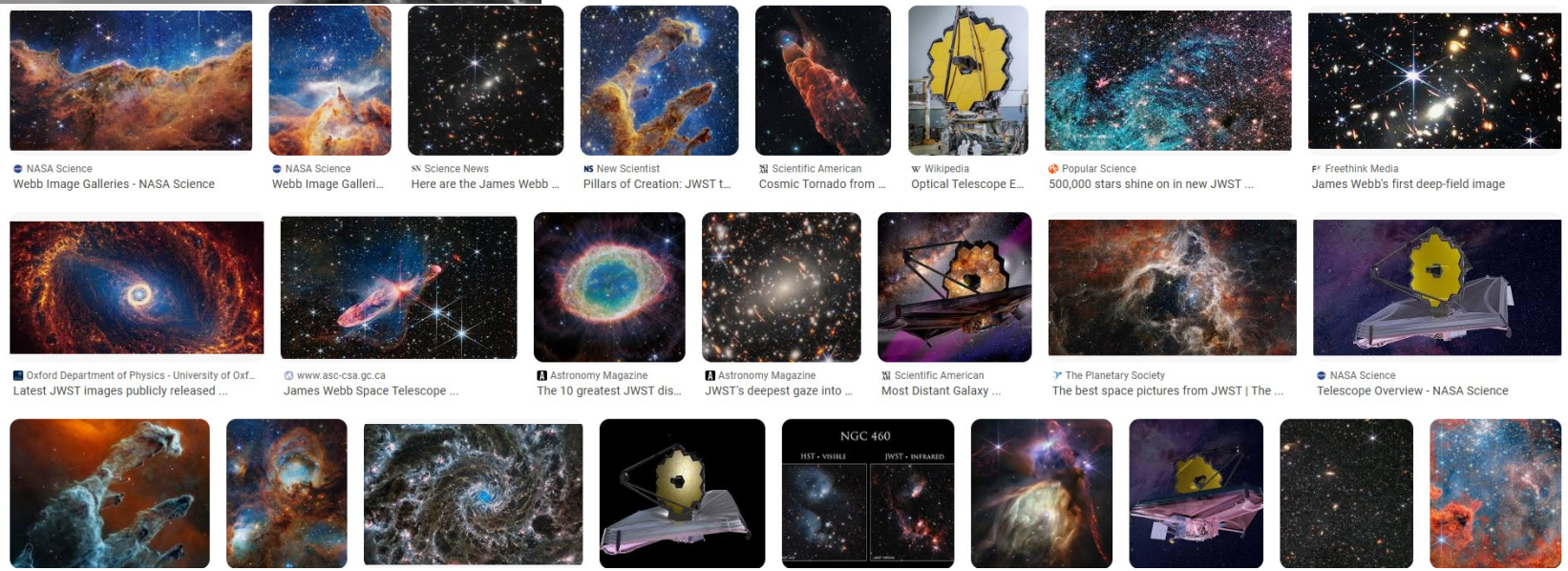
- EST, Firefighting, AEB, Boston Marathon, JWT, Security, Maritime, Missile Defense

AEB

Rescue

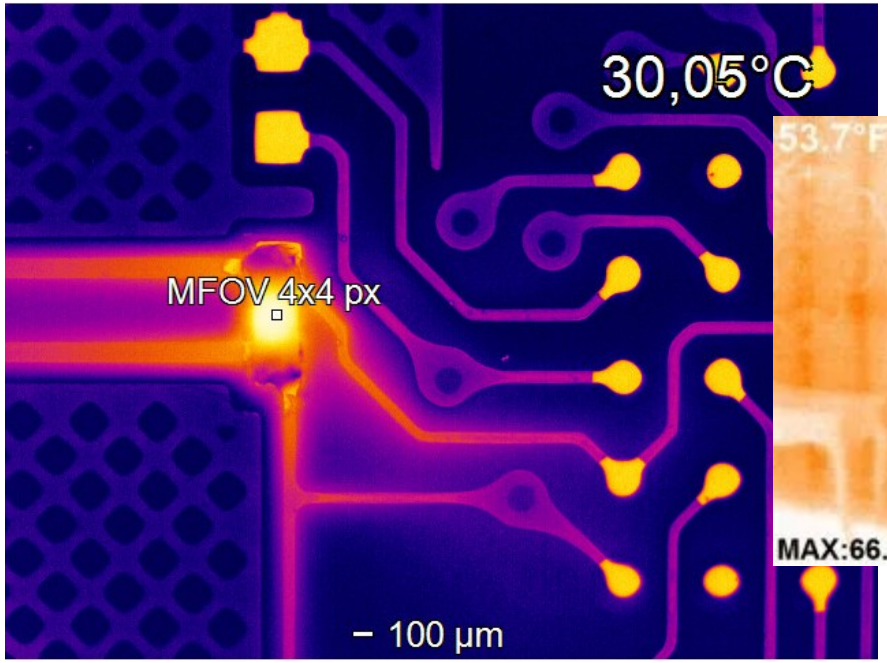
Missile Defense

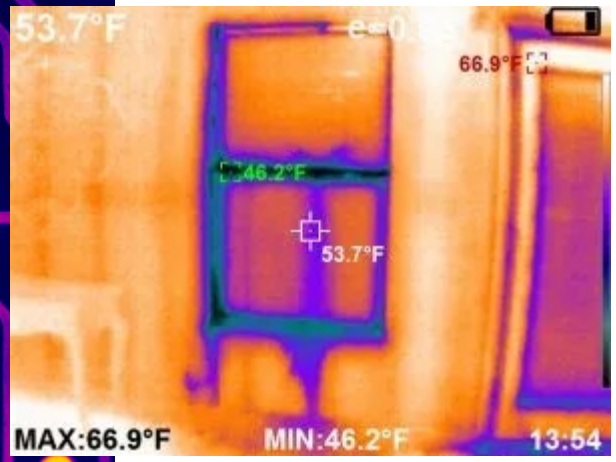




More IR Examples

Gas Leak Detection, PCB repair, water leak detection, checking insulation/home energy





Spectral Response and Detectable Gases

The mid wave gas detection camera has a detector response of 3-5 µm which is further spectrally adapted to approximately 3.3 µm by use of a cooled filter. This makes this particular model of camera most responsive to the gases commonly found in the petrochemical industries. The camera can detect many gases but it has been laboratory tested against 19 which are:

- Benzene
- Butane
- Ethane
- Ethylbenzene
- Ethylene
- Heptane
- Hexane
- Isoprene
- MEK
- Methane
- Methanol
- MIBK
- Octane
- Pentane
- 1-Pentane
- Propane
- Propylene
- Toluene
- Xylene

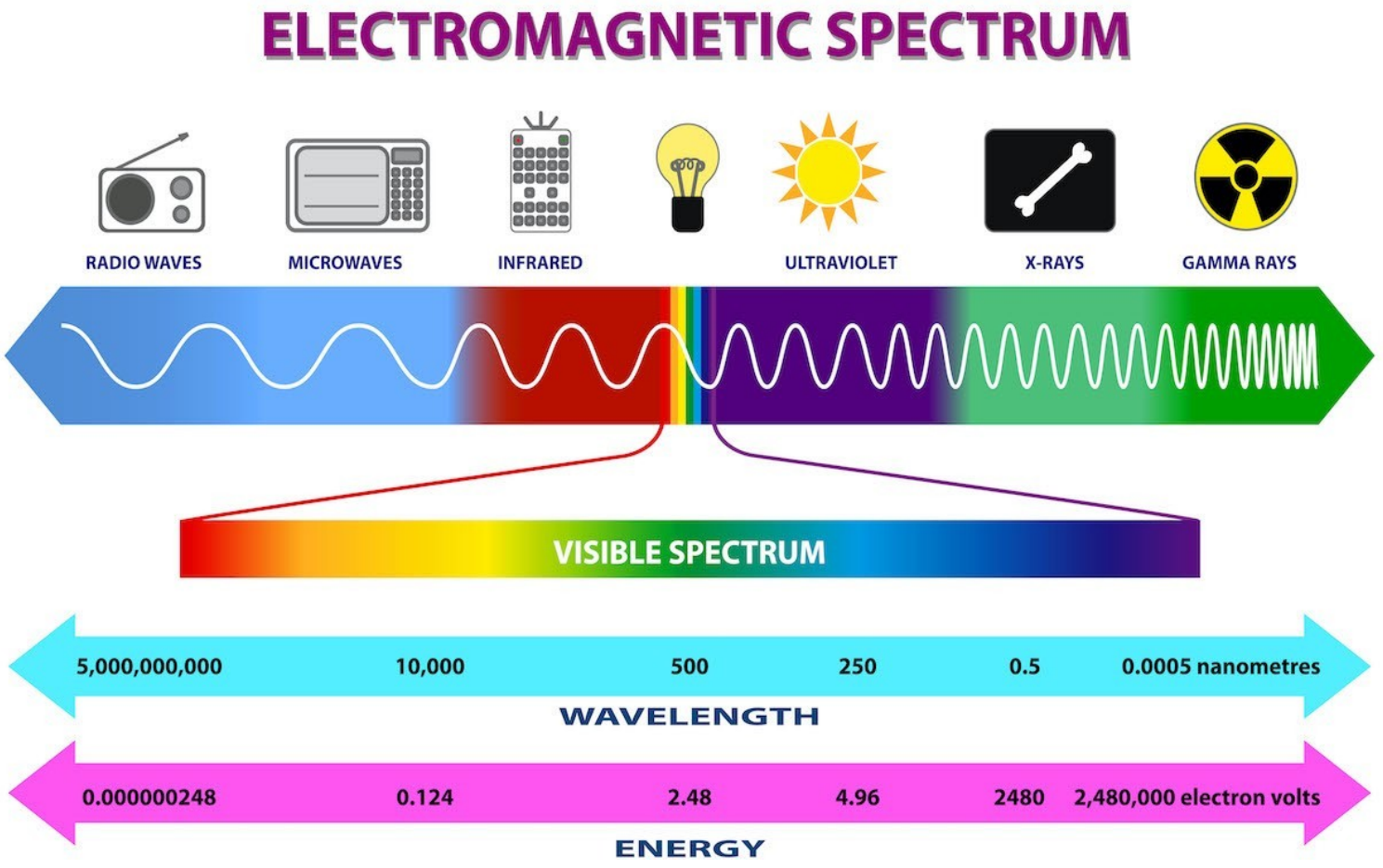
A leaking pressure gauge

What is IR?

It’s ‘light’ !

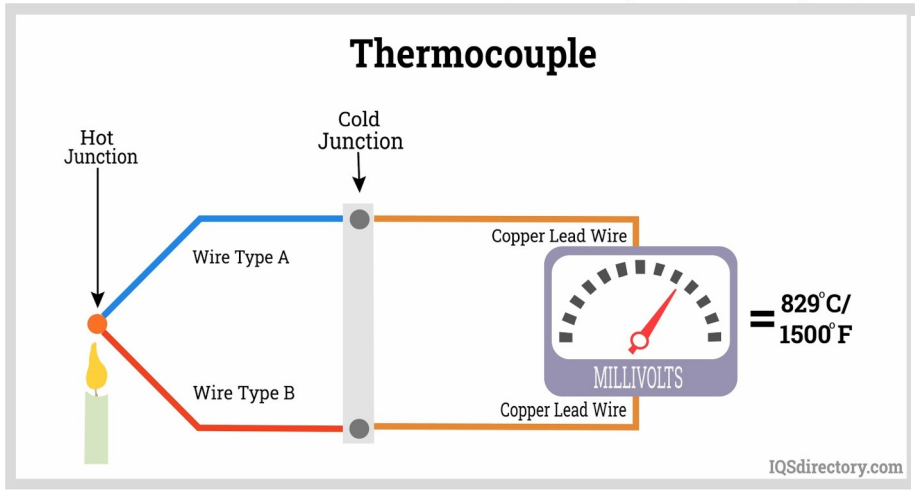
- Sir William Herschel – 1800’s
- Just below visible band
- Has ‘colors’
  - Short - SWIR 0.7 - 1.7um
  - Mid - MWIR 3 - 5um
  - Long – LWIR 7 – 14um

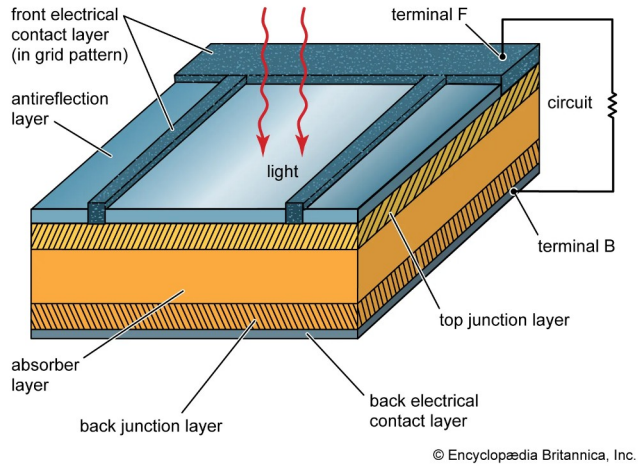
Thermal is LWIR



Detecting IR Energy

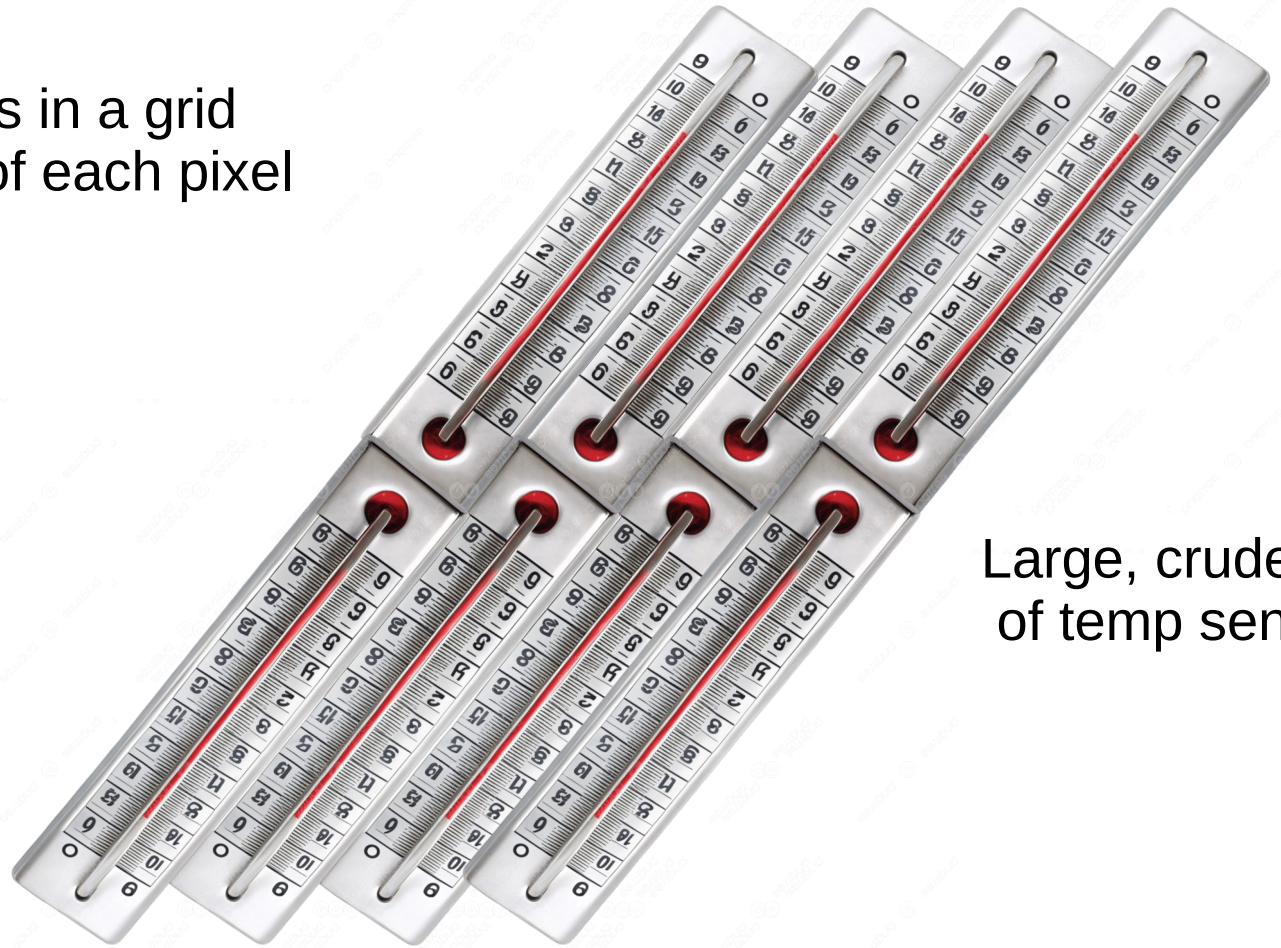
- Touch
- Thermometer
- Thermoelectric effect
  - Thermocouples / Thermopiles
- Resistance changes
  - Thermistors
- Detecting Photons
  - “Solar Cells”/Photodiodes





How to Make an IR Picture ?

- Arrange IR sensors in a grid
- Read temp value of each pixel
- 1 sensor = 1 pixel

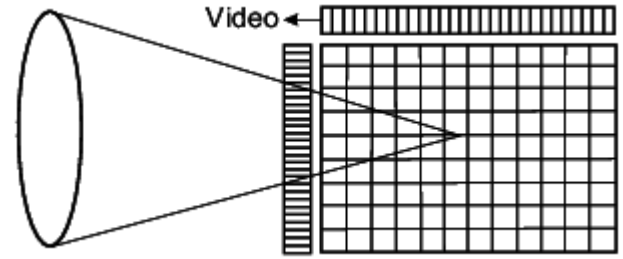


Large, crude 2x4 array
of temp sensors

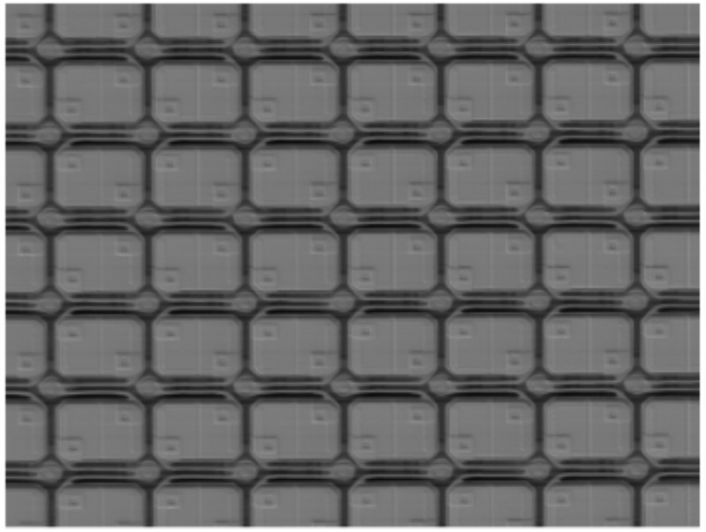
Scaling It Up (down?)

Replace film with Focal Plane Array (FPA)

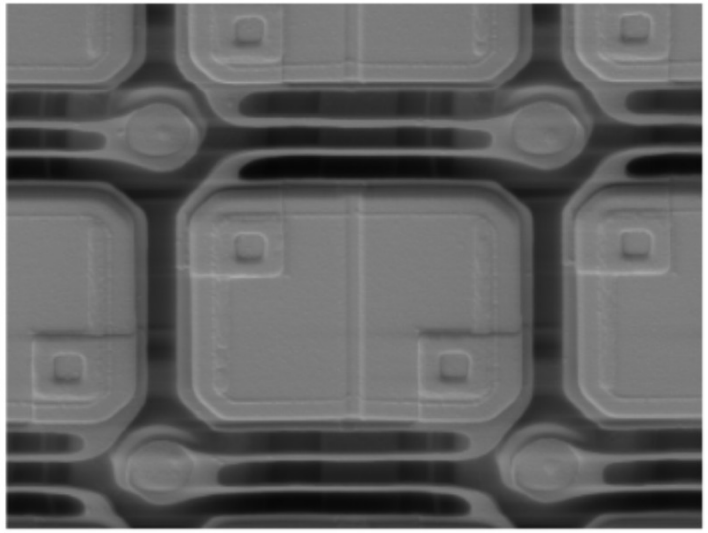
- Tiny detectors (microns)



Array of Bolometer Sensors

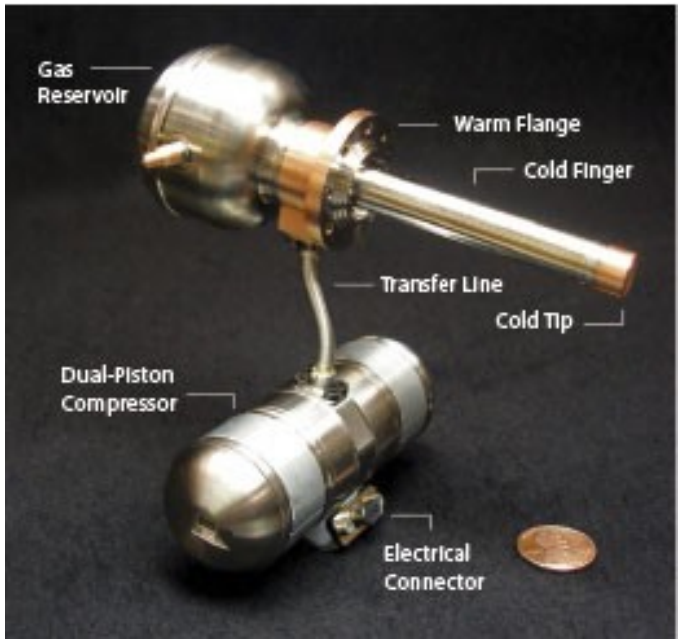


Closeup

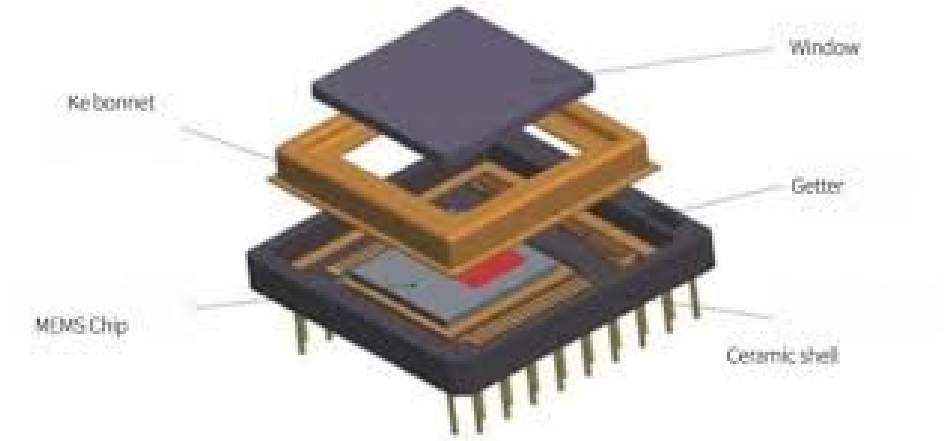


IR Imaging Detector Types

- Photon Detector - “Cooled”
  - Each pixel collects electrons (wells)
  - Cryogenically cooled (-321 deg F)
  - Power hungry / expensive
  - Bigger
  - Sensitive, Fast response time



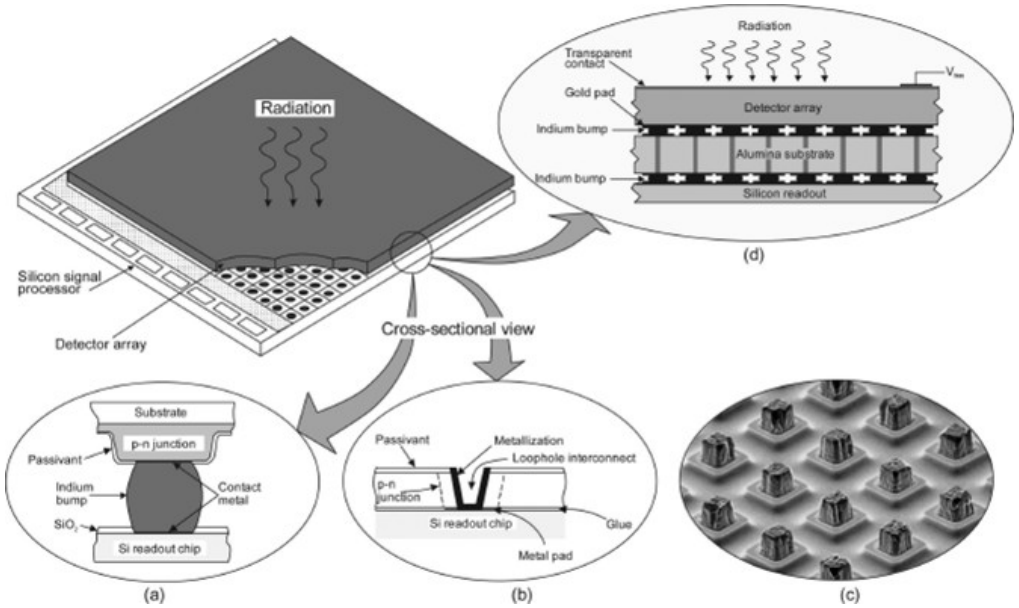
- Thermal Detector - “Uncooled”
  - Pixels convert energy to heat (absorber)
  - High vacuum package
  - Resistance changes with temperature
  - No cooler needed (power frugal)
  - Less sensitive, slow response time



ROIC – How to Read Each Pixel

Readout Integrated Circuit - ROIC

- Scans through the pixels one by one
  - Uncooled detector – converts resistance to a voltage
  - Cooled detector ‘counts’ electrons captured (voltage)
- Outputs each pixel’s value as volts or a digital value



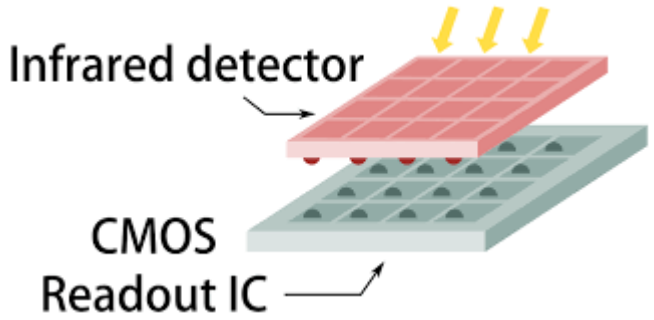
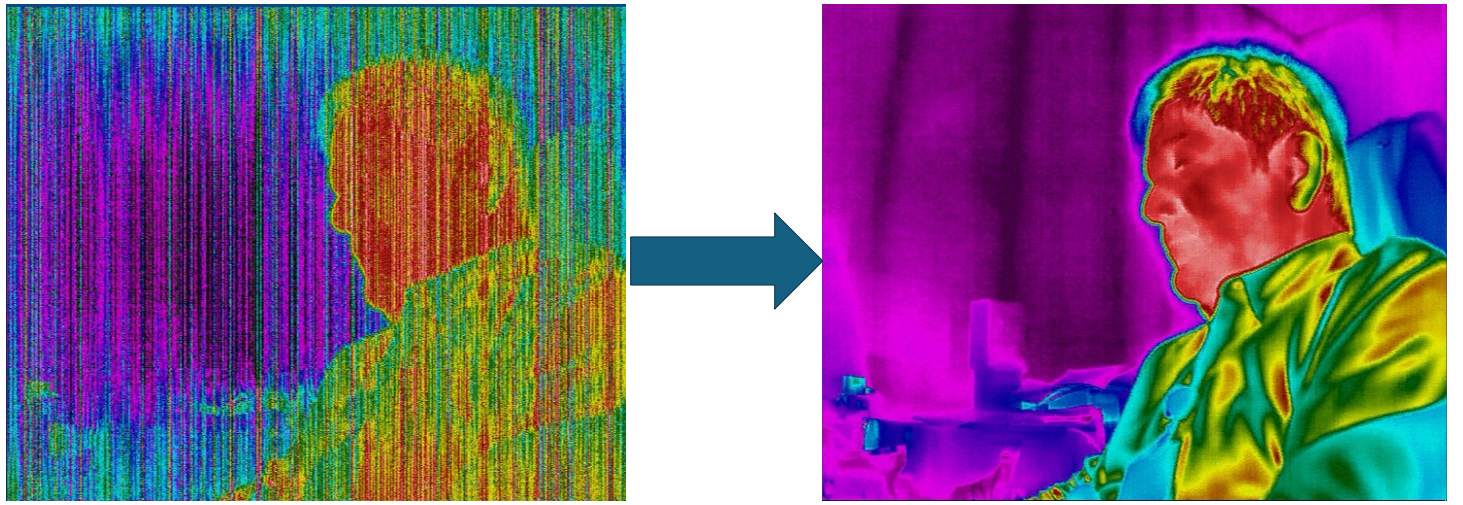


Image Processing

Microprocessor assembles pixel values into an image

- Calibration
  - Sensor Gain
  - Non-uniformity correction
  - Lens gain
  - Flat Field Correction
- Bad pixel replacement
- Contrast enhancement
- Noise Filtering
- AGC
- Noise filtering
- DeWarping

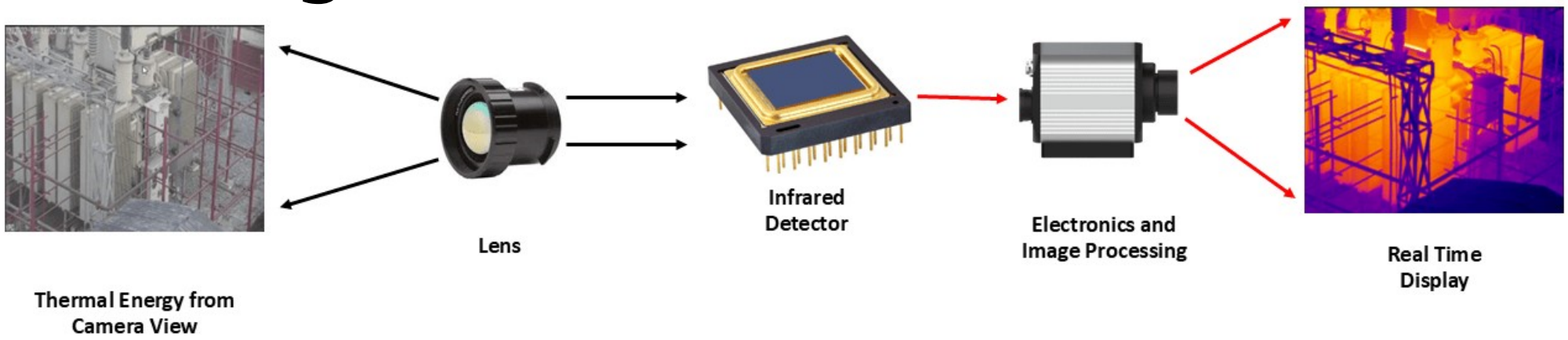


Raw

Corrected

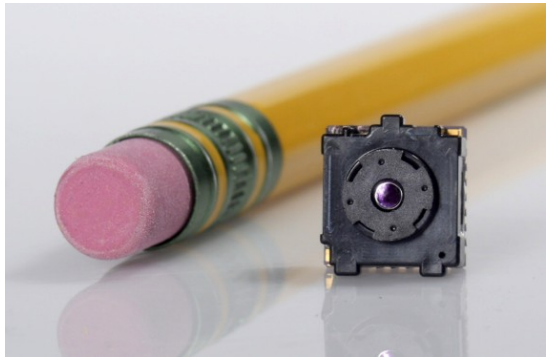
Colorized via Look Up Tables (LUT)

Creating an IR Camera



- Lens – focuses image (Ge, Si, ZnSe, Calcogenite)
- FPA – detects energy (detector, ROIC, vacuum package)
- Shutter – (NOT like in a visible camera!!)
- Multiple power supplies (6+ not uncommon)
- Electronics
- Firmware and software

Wrap-Up



Uncooled IR Cameras

- Cheaper (as low as $110)
- Smaller
- Can run off battery
- Useable images
- Fast startup time
- Long lifetime

Cooled IR Cameras

- Expensive (>$18K)
- Larger
- Faster frame rates
- Best image quality
- Startup time longer
- Cooler wears out