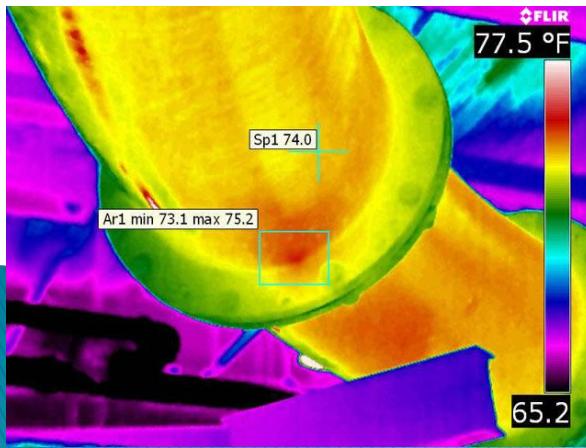


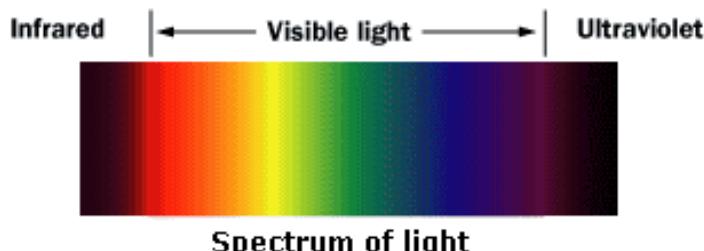


Infrared Vision



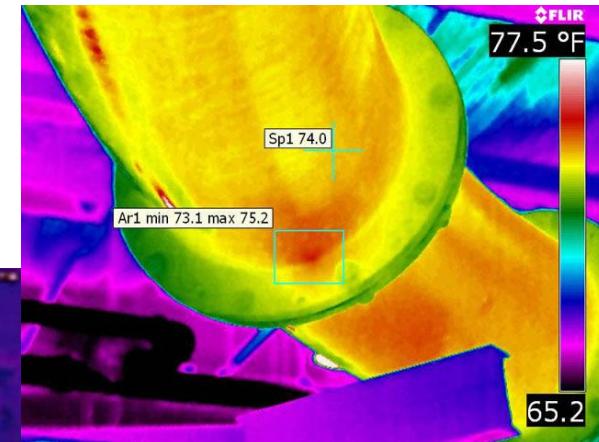
Basic principles

- ▶ The infrared light can be separated into three ranges:
 - Near-infrared (near-IR) – around visible, has wavelengths ranging from 0.7 to 1.3 microns
 - Mid-infrared (mid-IR) – has wavelengths ranging from 1.3 to 3 microns. Both this range as the previous one are widely used in electronic devices, among them the remote commands.
 - Thermal-infrared (thermal-IR) – Occupies the largest range of the infra-red spectrum, with wavelengths ranging from 3 to 30 microns.
- ▶ The biggest difference between the thermal-IR and the other is that this is emitted by a subject, instead of reflected. Infrared light is emitted by an object due to atomic level phenomena.



Applications

- ▶ Thermal vision equipment is ideal for:
 - Movement detectors
 - Vision in the near-absolute dark with very little or no ambient light.
 - Quality inspection
 - Temperature measurement
 - Materials characterization



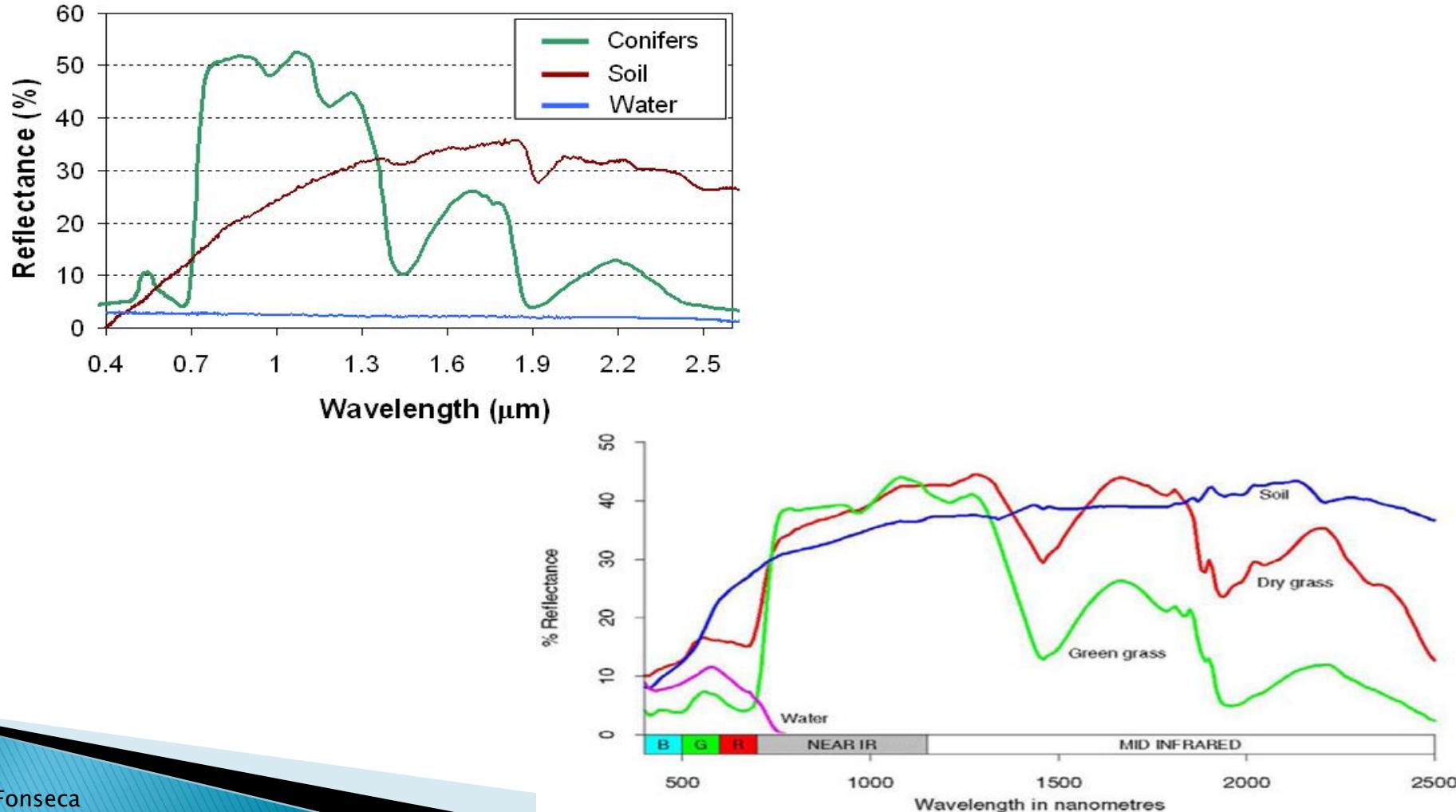
Equipment technologies

- ▶ Two technologies for infrared vision exists:
 - Image intensification(I²)
 - Thermal Image.
- ▶ Because the cost is lower and the images are easier to interpret, the **image intensification** is the most used in police equipment.
- ▶ The **thermal images** show a grayscale image depending on the temperature of the object

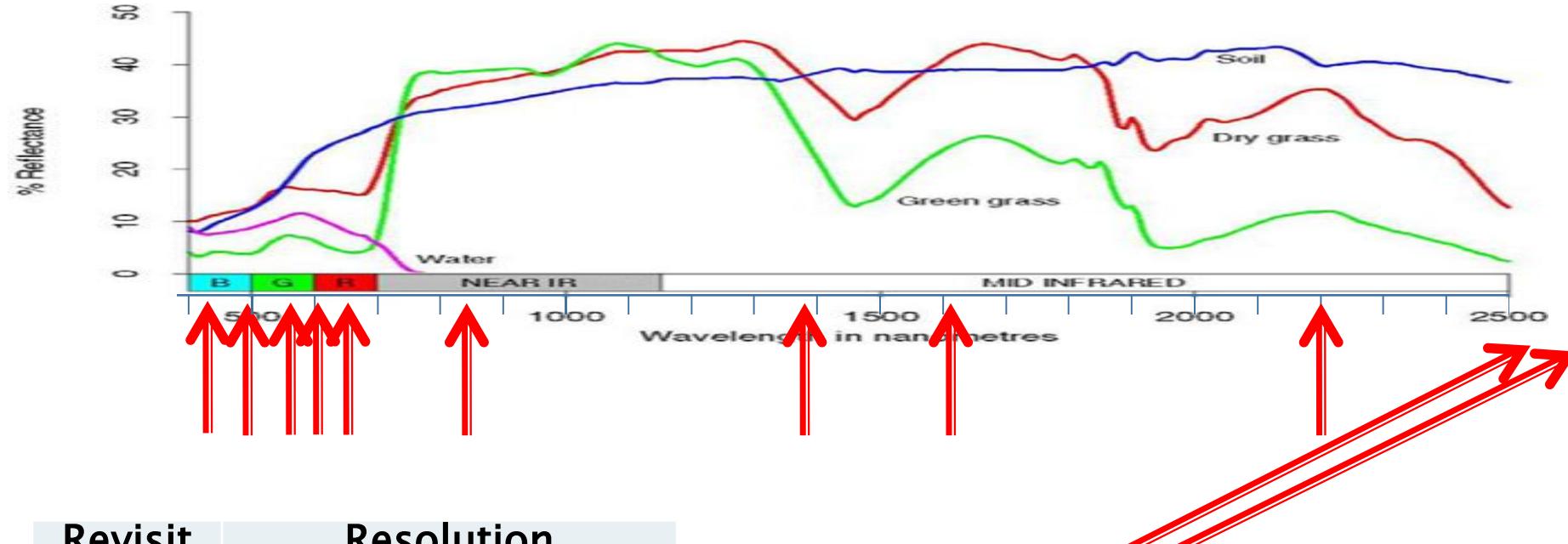
Multi-spectral imaging



Multispectral/ Hiperespectral analysis



Satellite – Landsat 8

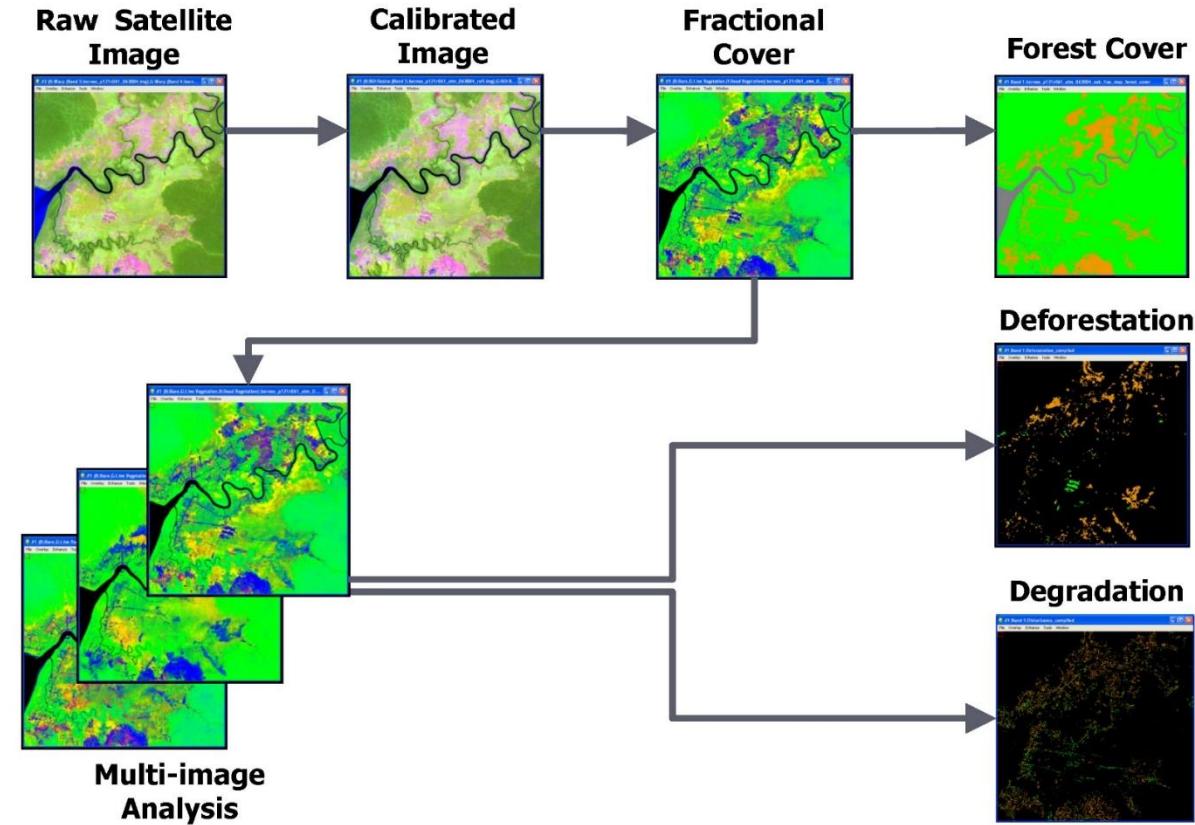


Revisit	Resolution
16 days	15 m/px – panchromatic 30 m/px – multispectral 100 m/px – thermal

Spectral Band	Wavelength	Resolution
Band 10 – Long Wavelength Infrared (Thermal)	10.30 – 11.30 μm	100 m
Band 11 – Long Wavelength Infrared (Thermal)	11.50 – 12.50 μm	100 m

7

Example of application to forests



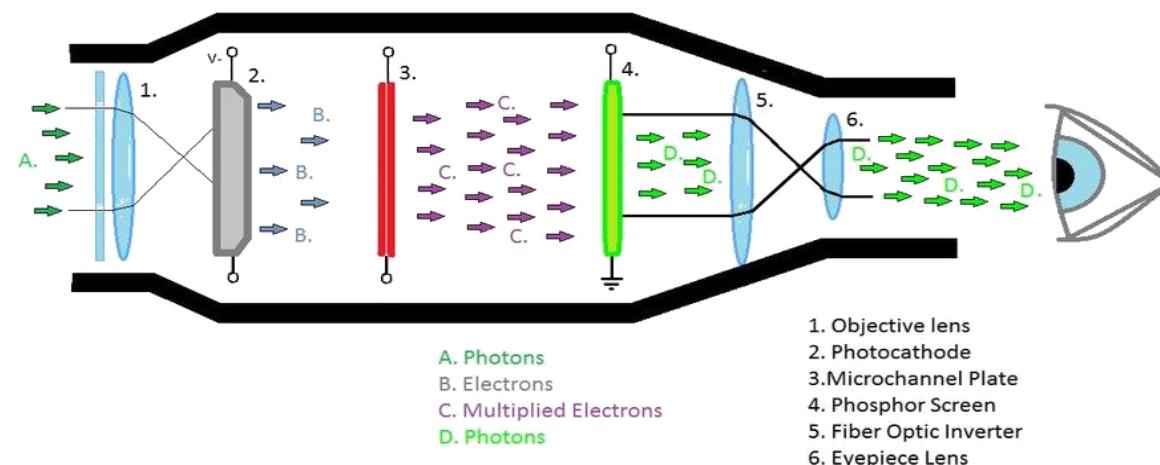
<http://claslite.carnegiescience.edu/en/about/software.html>

Image intensifiers

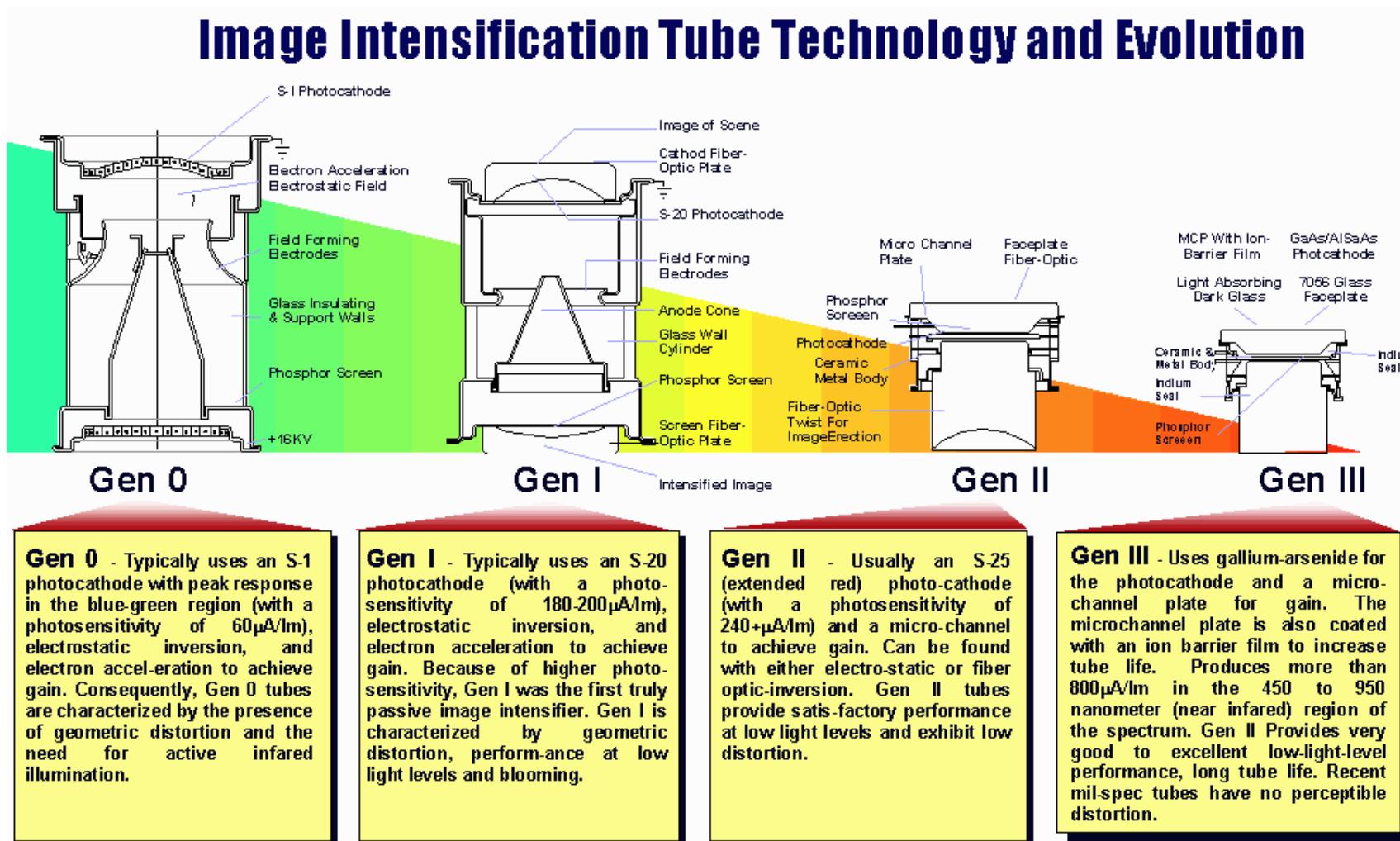


Image intensifiers

- ▶ The light enters the lens through a device that directs to a photocathode powered by a high voltage source
- ▶ Electric charges are accelerated through a vacuum chamber until they reach a phosphor screen (identical to a TV screen) where the image is formed.



Equipment Generations



Generation 0

- ▶ The generation 0 consisted essentially by nocturnal sight used in World War II and in the Korean war.
- ▶ Were image converters that required IR lighting to illuminate the scene.



Generation 1

- ▶ Equipment developed for the Vietnam war during the years 60, constituted the first generation image intensifiers.
- ▶ Consisting of three intensifiers in series, produced images of acceptable quality in the Center, but with significant distortion in the periphery.
- ▶ Currently, are used in low-cost equipments.



Generation 2

- ▶ This generation is due to the development of microchannel plate (MCP) in the late 60.
- ▶ This technique allowed to accelerate and multiply the electrons providing a gain similar to the previous generation.
- ▶ With this technique it was possible to:
 - reduce the dimensions
 - reduce weight of the devices
 - increase image quality especially when bright lights are in the scene.



Generation 3

- ▶ This generation was developed during the years 70 and was released in the early 80.
- ▶ Was the result of two technological advances: the photocathode of arsenate of gallium arsenide (GaAs) and filtering plate ion barrier "microchannel".
- ▶ This technology increased the lifetime of image tubes. GEN3 has more than 10000 hours of expected life, Gen2 between 2000 and 4000 hours.



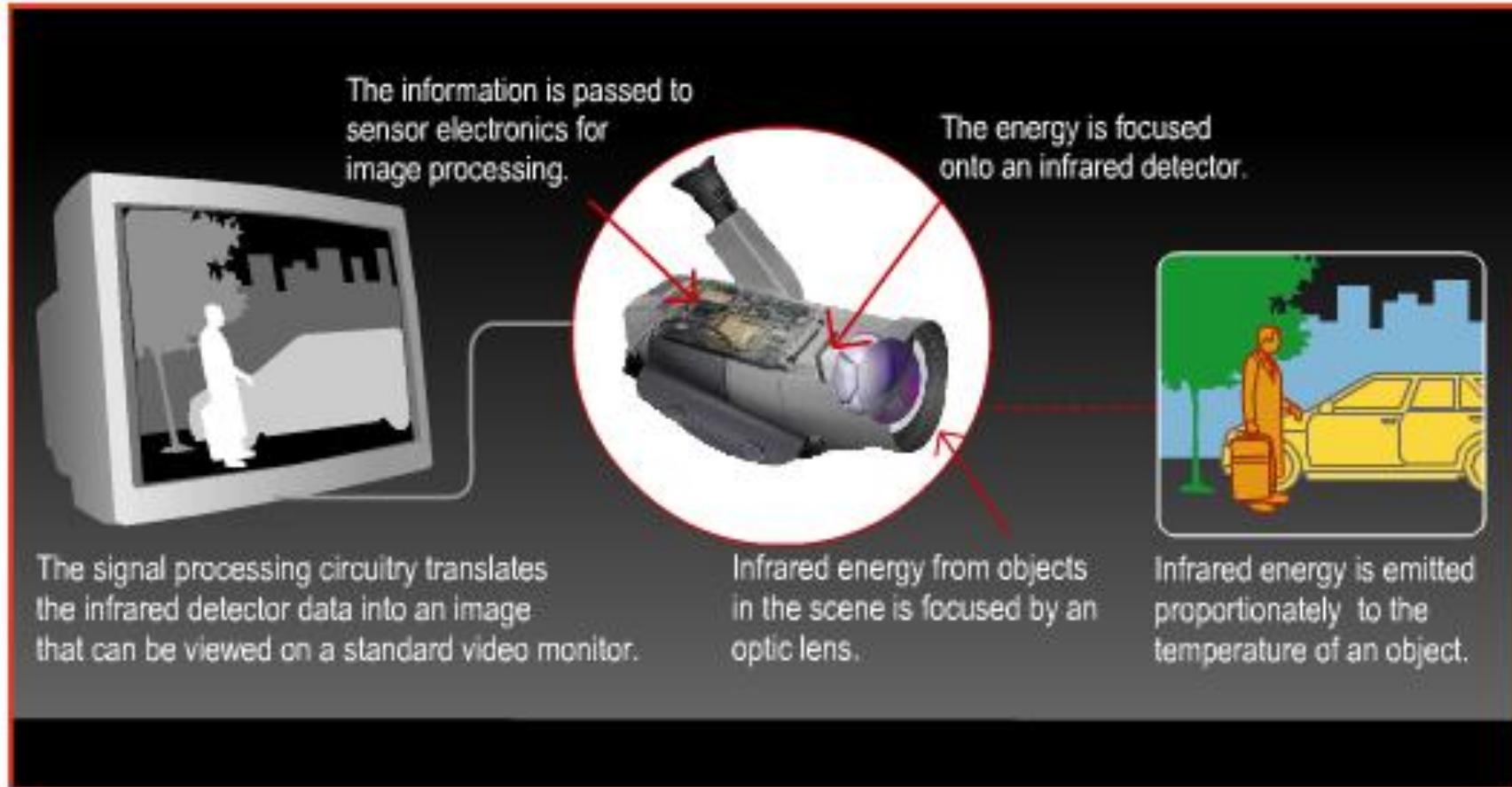
Thermal Image



Main Features

- ▶ Most thermal imaging devices:
 - Work at 30 frames per second
 - Low resolution (320 x 240, & 640 x 480 pixels)
 - Capture temperatures between -20/-40° Celsius and 2000° Celsius with a precision of 0.04° Celsius /30°C
- ▶ Two basic types of equipments exist:
 - **Un-cooled:** most common.
 - Work at room temperature.
 - Silent, have instant turn-on and work with batteries.
 - **Cryogenically cooled:**
 - More expensive and sensitive, kept at zero degrees Celsius.
 - Good resolution and sensitive. (differences of 0.1°C at more than 300m distance)

Working principle



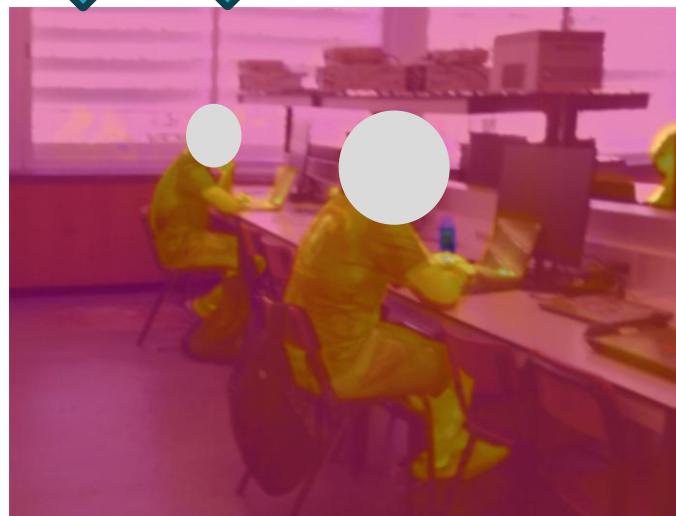
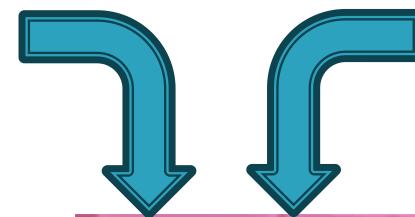
Dahua TPC-BF2120 THERMAL CAMERA

- ▶ Dual Sensor
 - Thermal (160 x 120px)
 - Visible (2Mp)

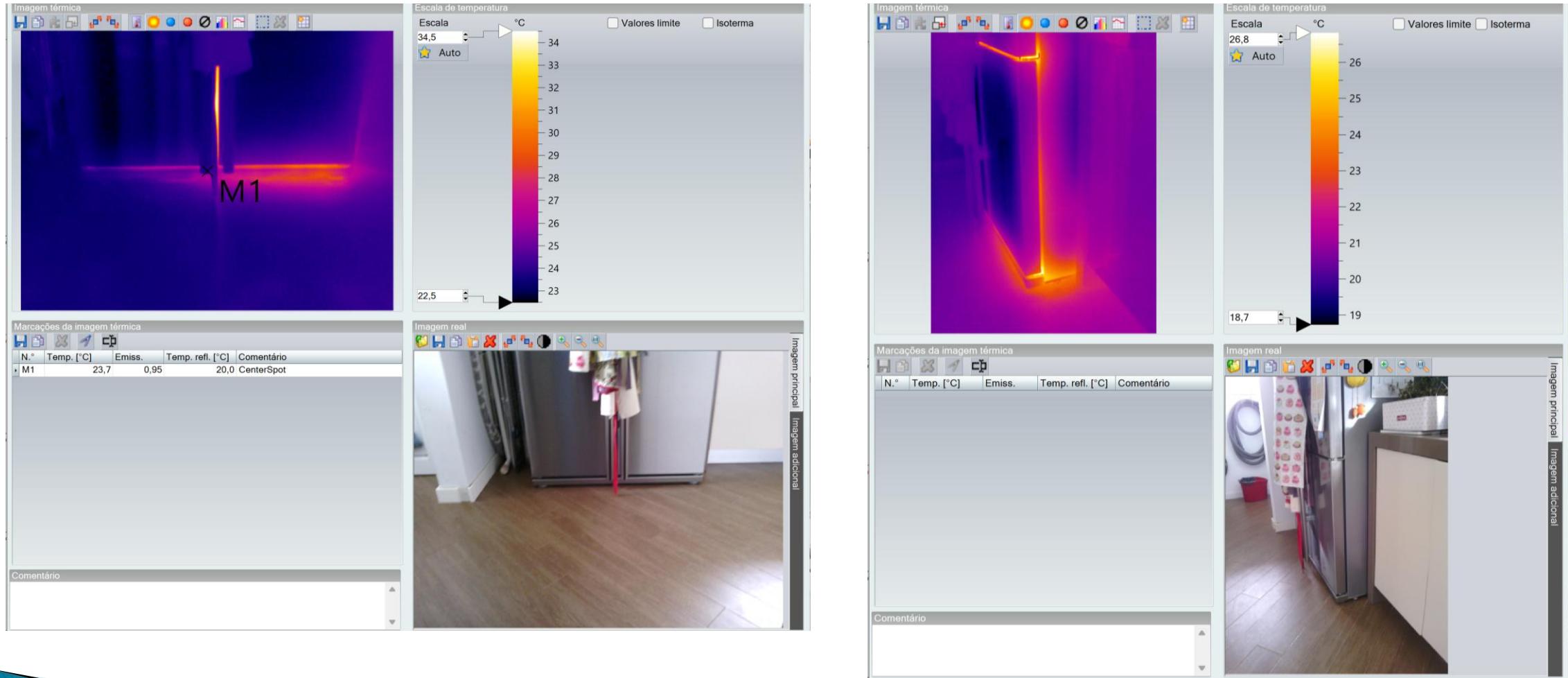


Testo 872s

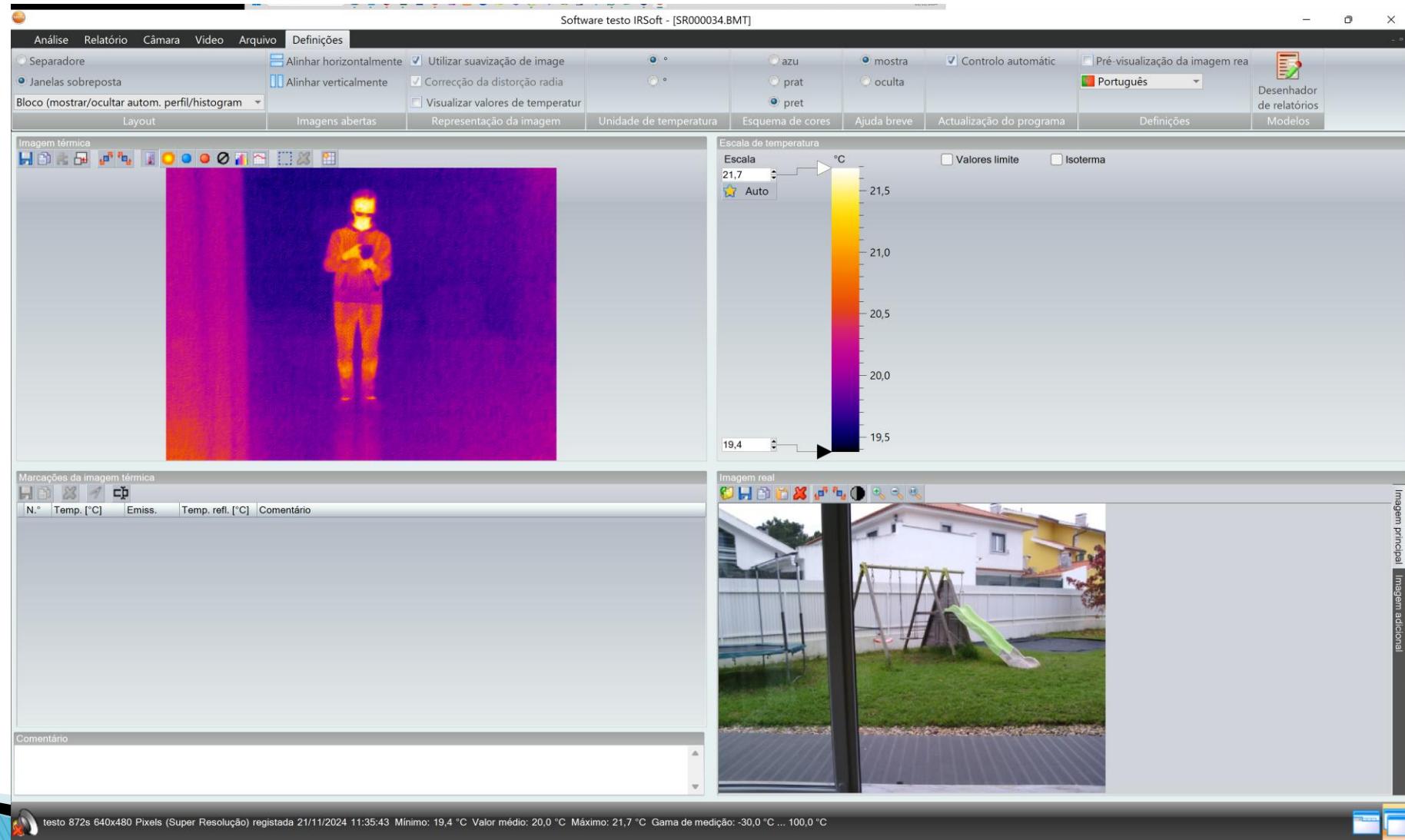
- ▶ Dual Sensor
 - Thermal (320 x 240px)
 - Visible (5Mp)



Thermal behavior of the refrigerator door

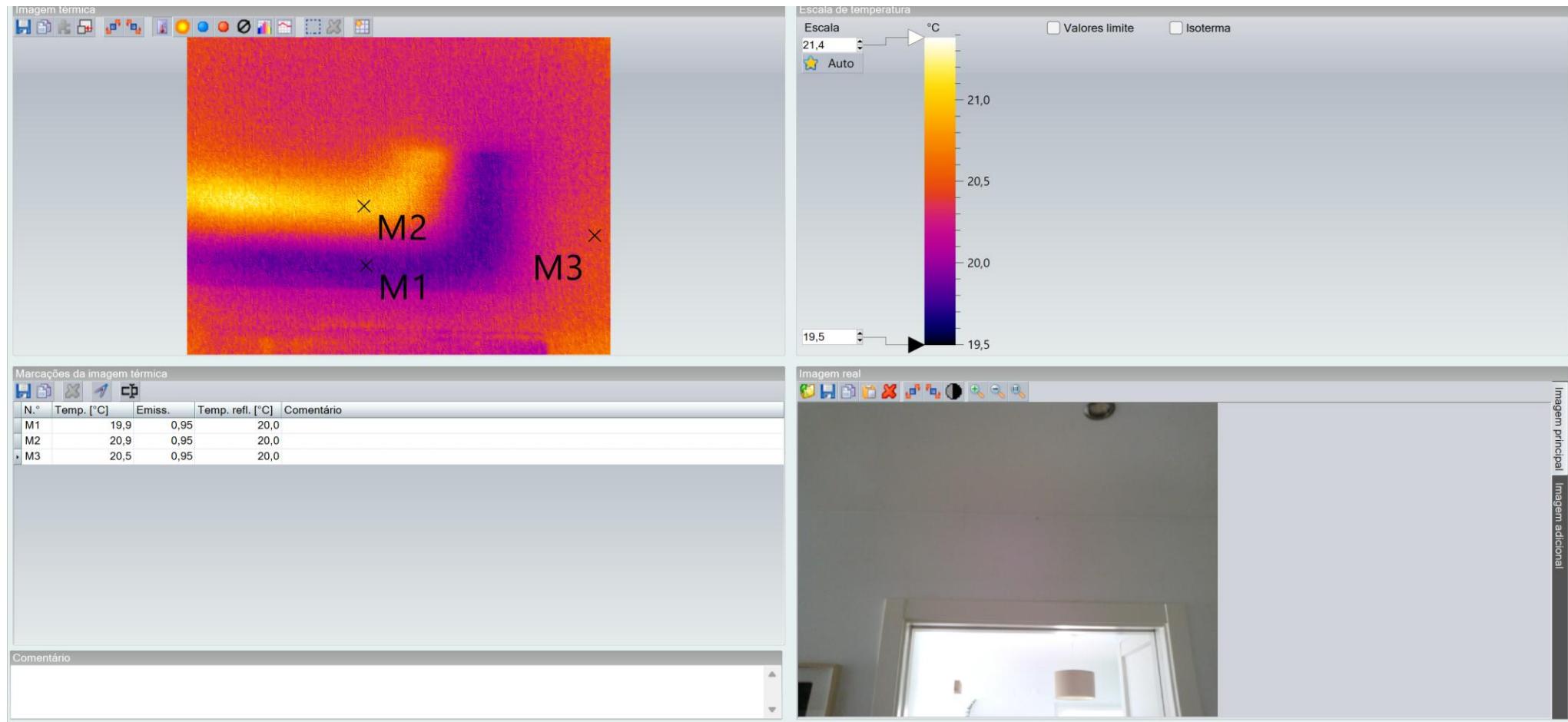


Mirror effect

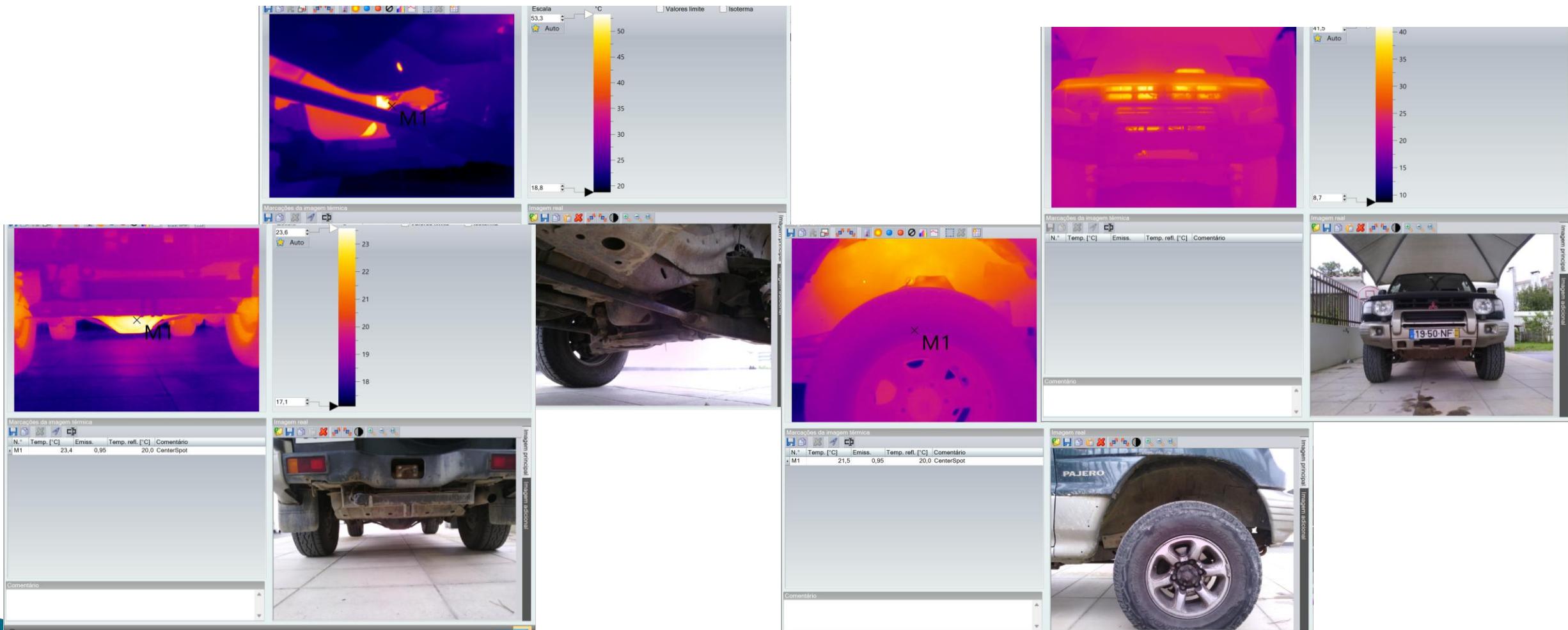


10/11/2025

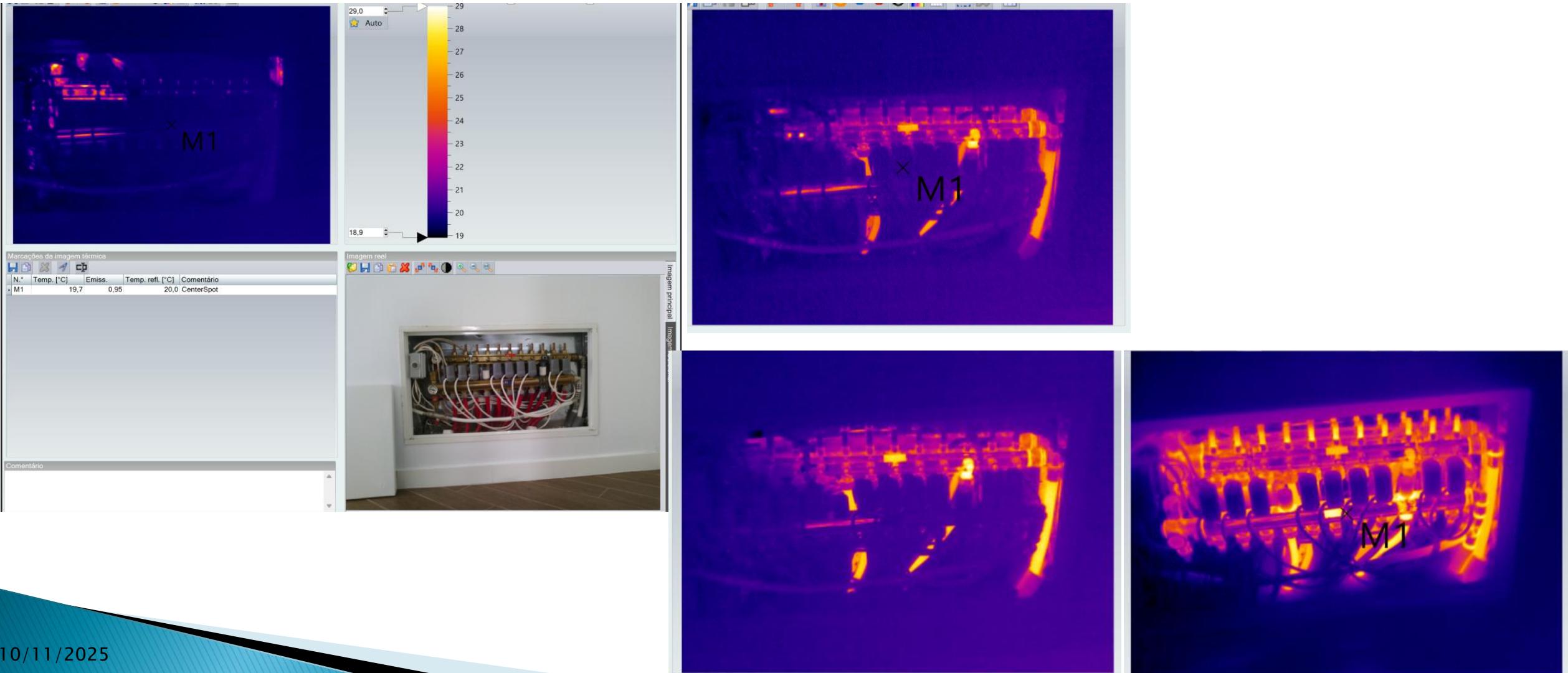
Hot and cold water piping



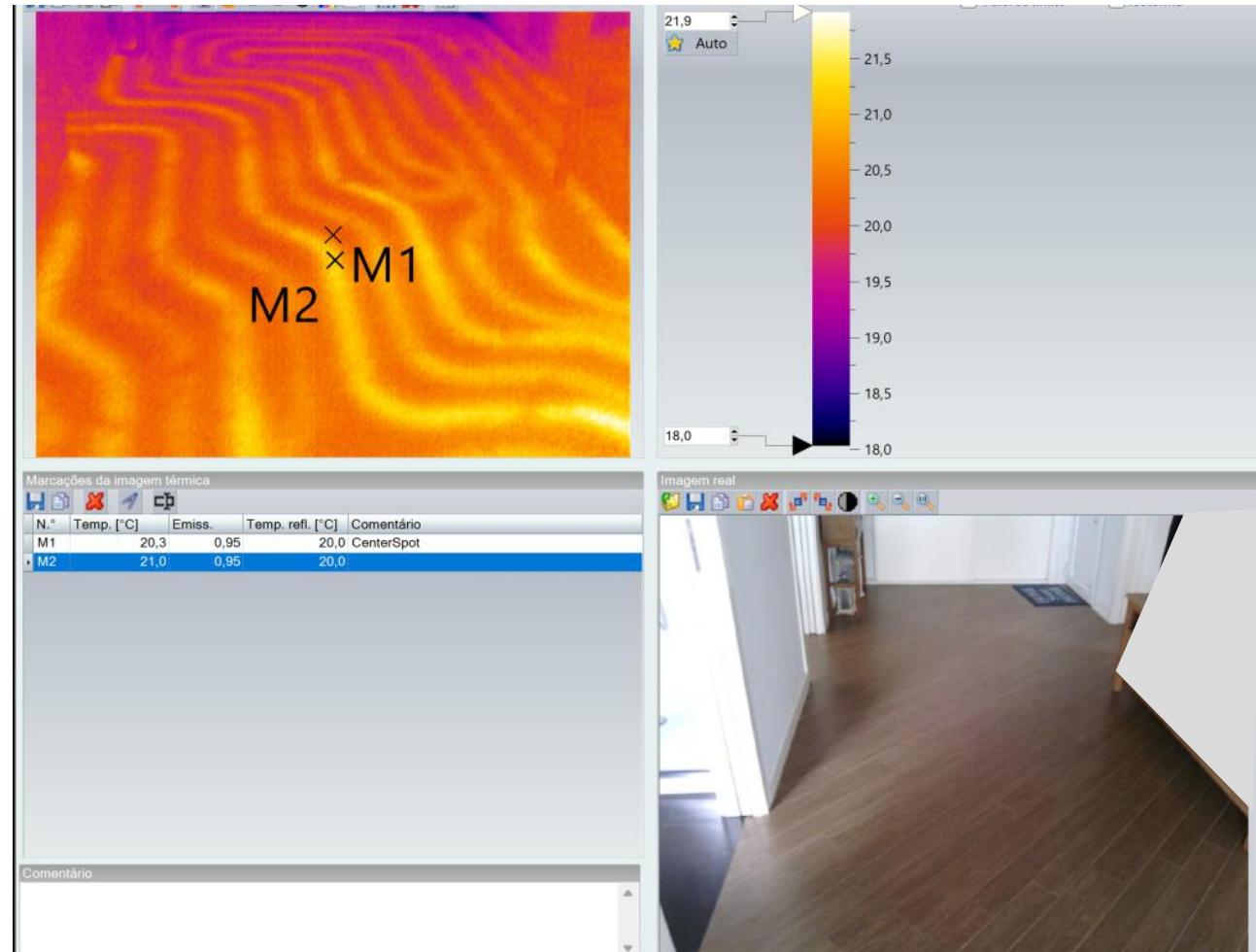
Automotive Diagnostics / Maintenance



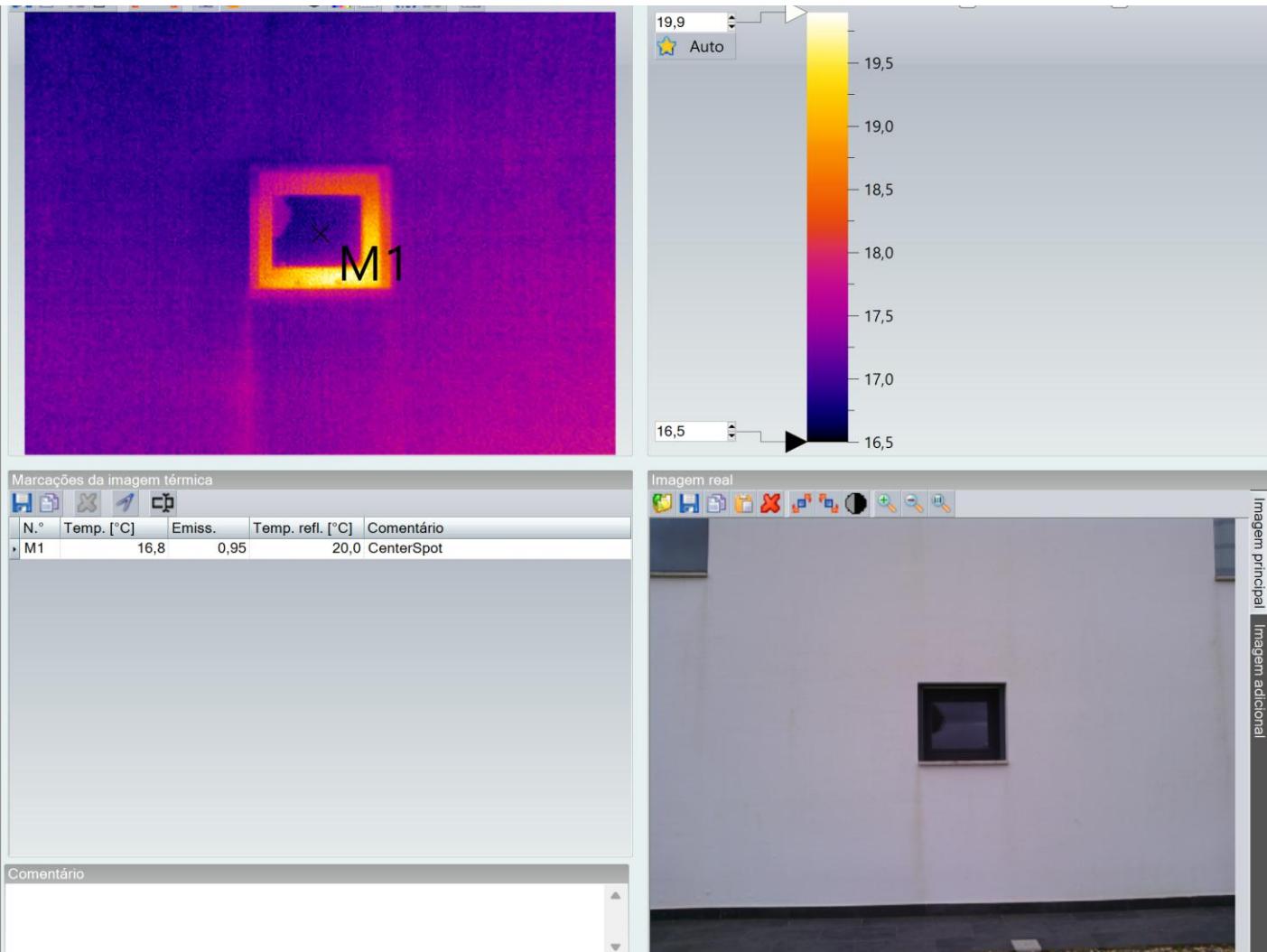
Water Heating System Inspection



Water Heating System Inspection



Exterior Walls



Thermal cameras



Low-cost

Camera HT-175
– 32x32 pixels –
118€ (2020)



High-end

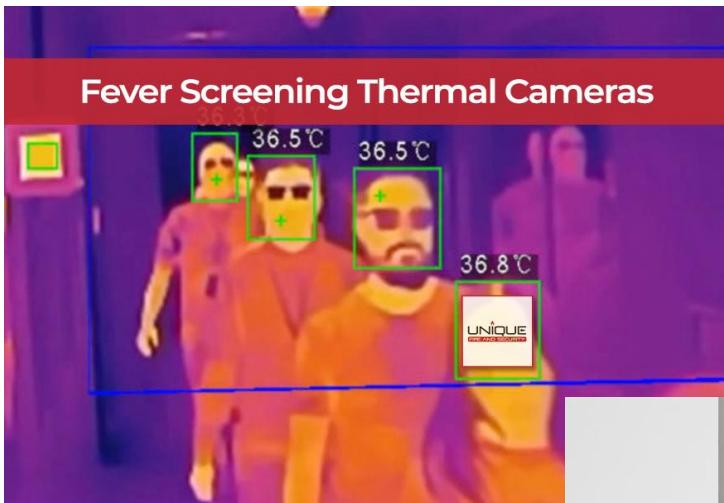
Camera FLIR T600-25
– 480x360 pixels –
±18000€ (2020)

FLIR T1020-45
– 1024x768 pixels –
±40000€ (2020)

Thermal Video



Human Body Temperature System



Digital thermometers without contact

Technical use



Domestic Use

