Optikos Corporation

Why ignoring emissivity in thermal camera testing should not be a gray area

AutoSens Europe
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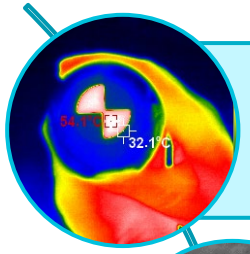
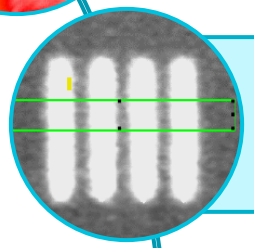
optikos

Overview



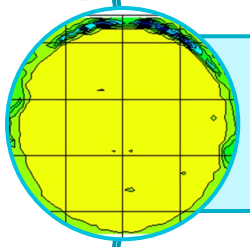
Thermal Camera Function

Sensitivity to temperature difference



Test Capability Needed

Controlled radiation contrast

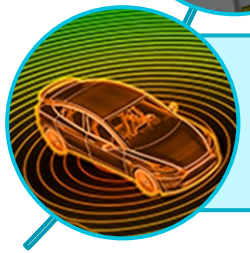


Technical Challenge

Unideal emissivity of test sources

Solution

Radiometers for emissivity characterization

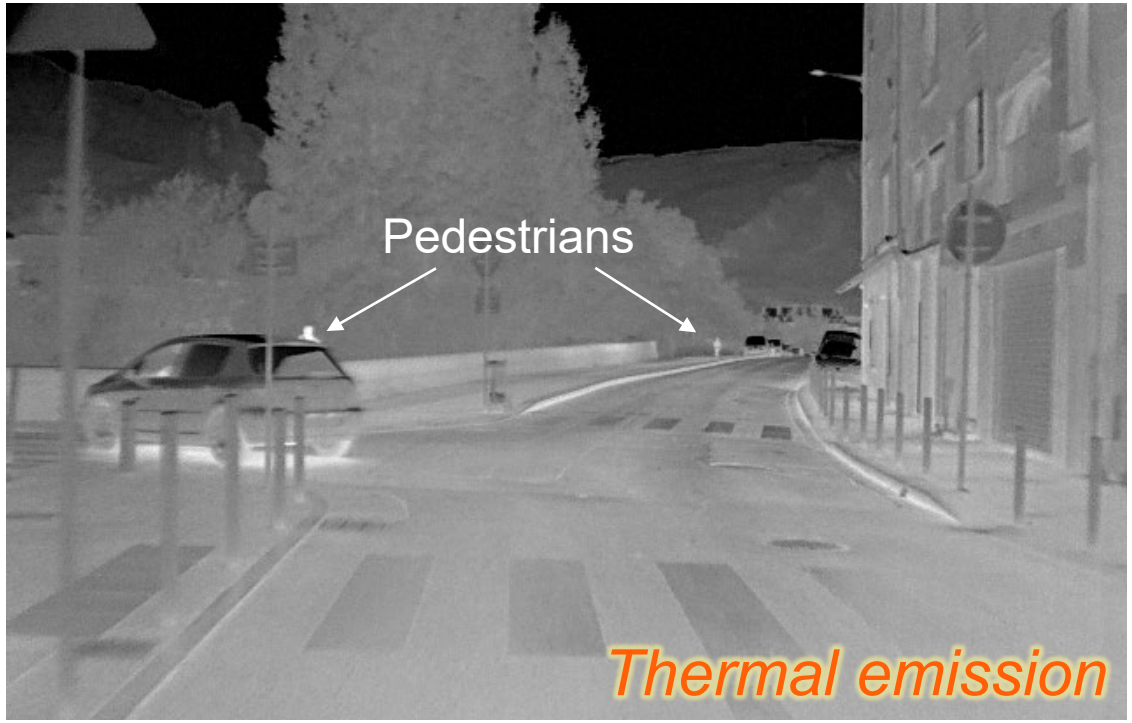


Unlock

Composite image quality KPIs

Nighttime: ADAS cannot rely on reflected environmental light.

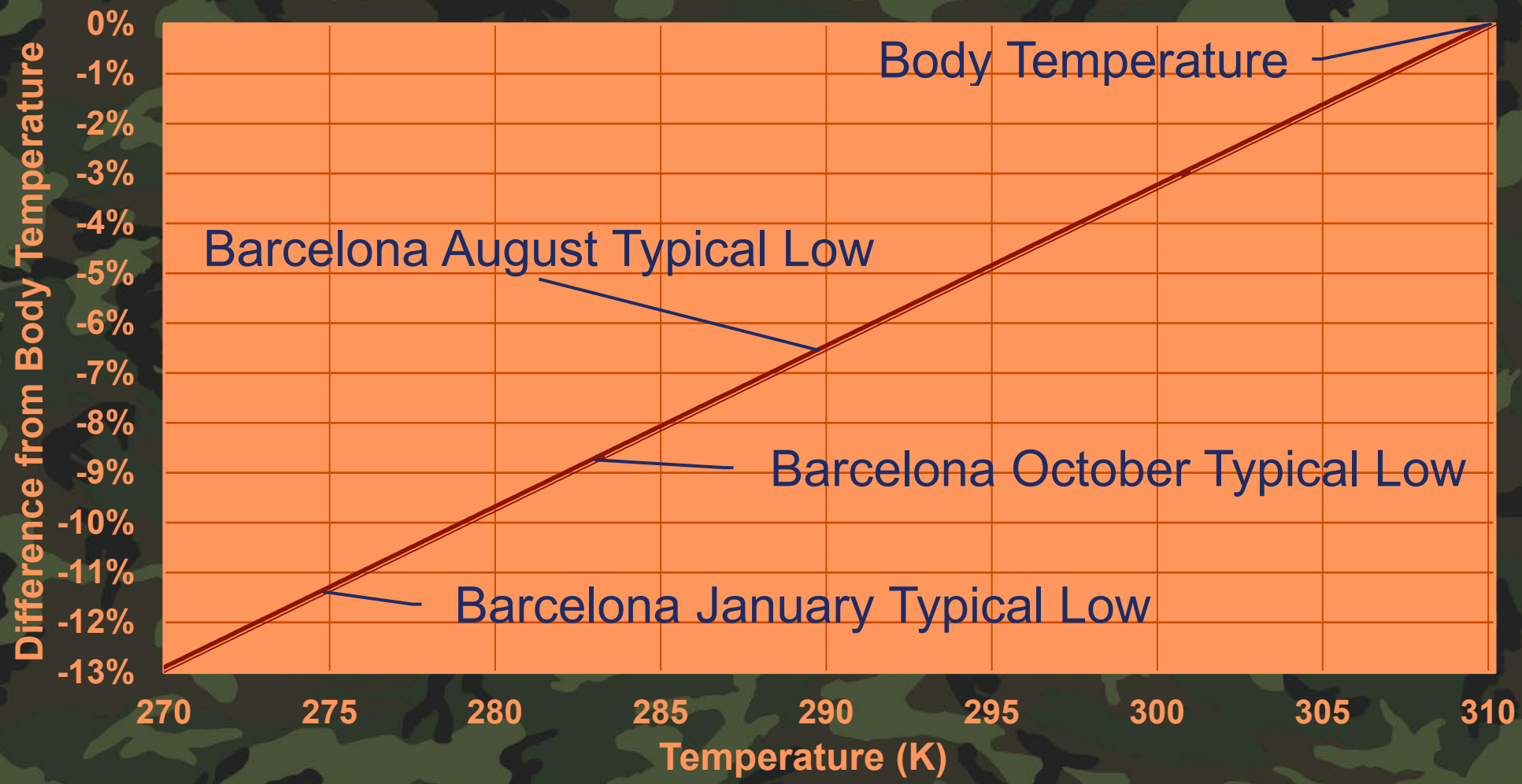
Solution: LWIR cameras sense thermal emission.



Hotter objects → brighter “light bulbs”

Images Credit: LYNRED, LYNRED Mobility Dataset V1 (2025), https://www.lynred.com/lynred-mobility-dataset

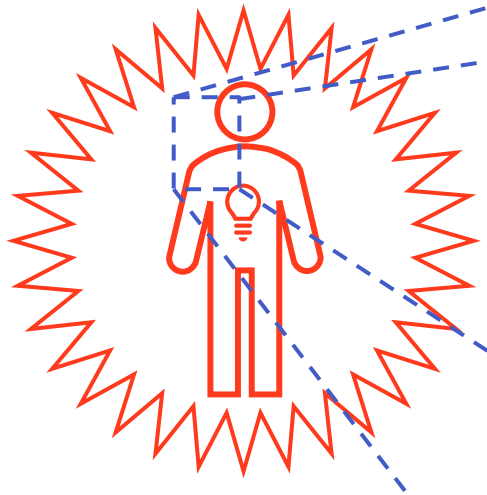
The road presents low thermal contrast…

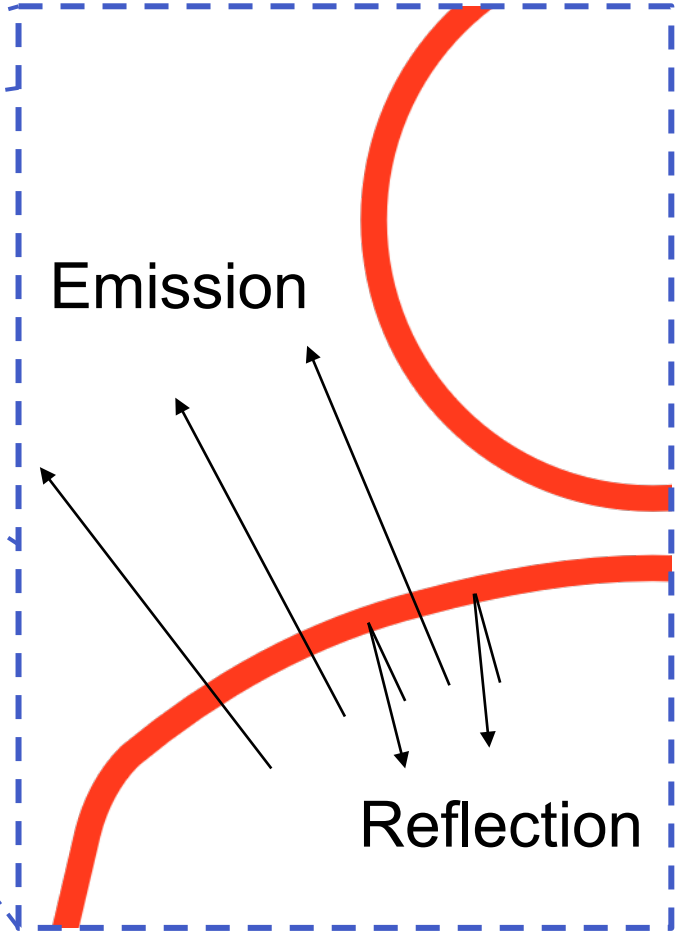


…like trying to see pedestrians wearing camouflage.

Simulating Thermal Contrast Requires Knowledge of Physical Temperature AND Emissivity

- No object is a perfect emitter– some light reflects back inward.





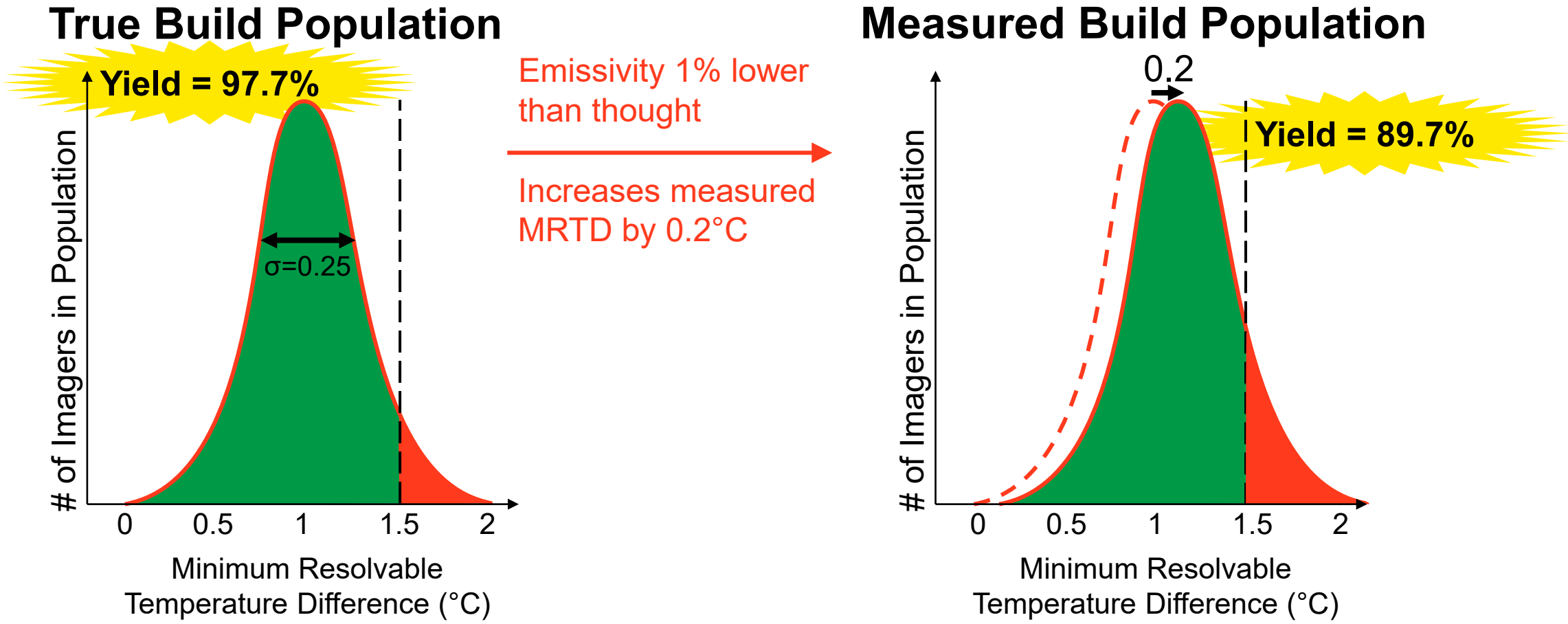
Physical Temperature
Determines how many photons are generated

Radiant Temperature
What a thermal camera sees

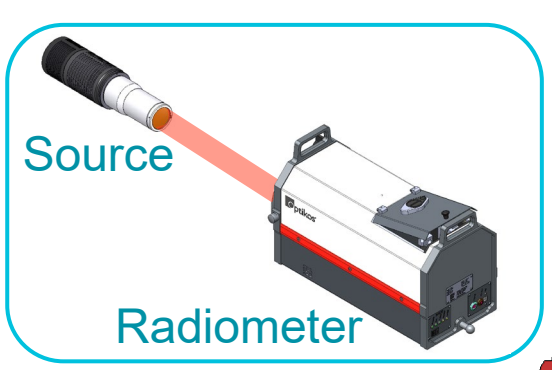
Emissivity
% photons that radiate out of the object

Example Production Testing Scenario

Emissivity errors contribute systematic offsets to sensitivity measurements!



Radiometer Operating Principles



Infrared Beam from Source Under Test

Ambient Reference Blackbody

LN2 Cooled Detector

Objective Lens

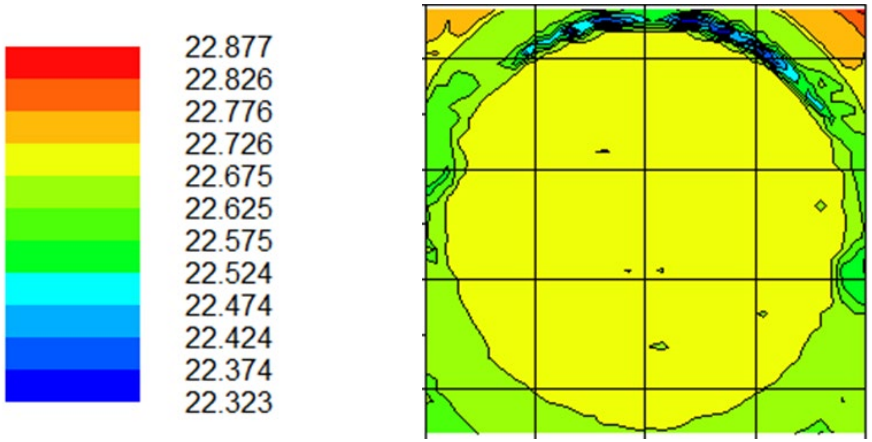
Reflective Chopper

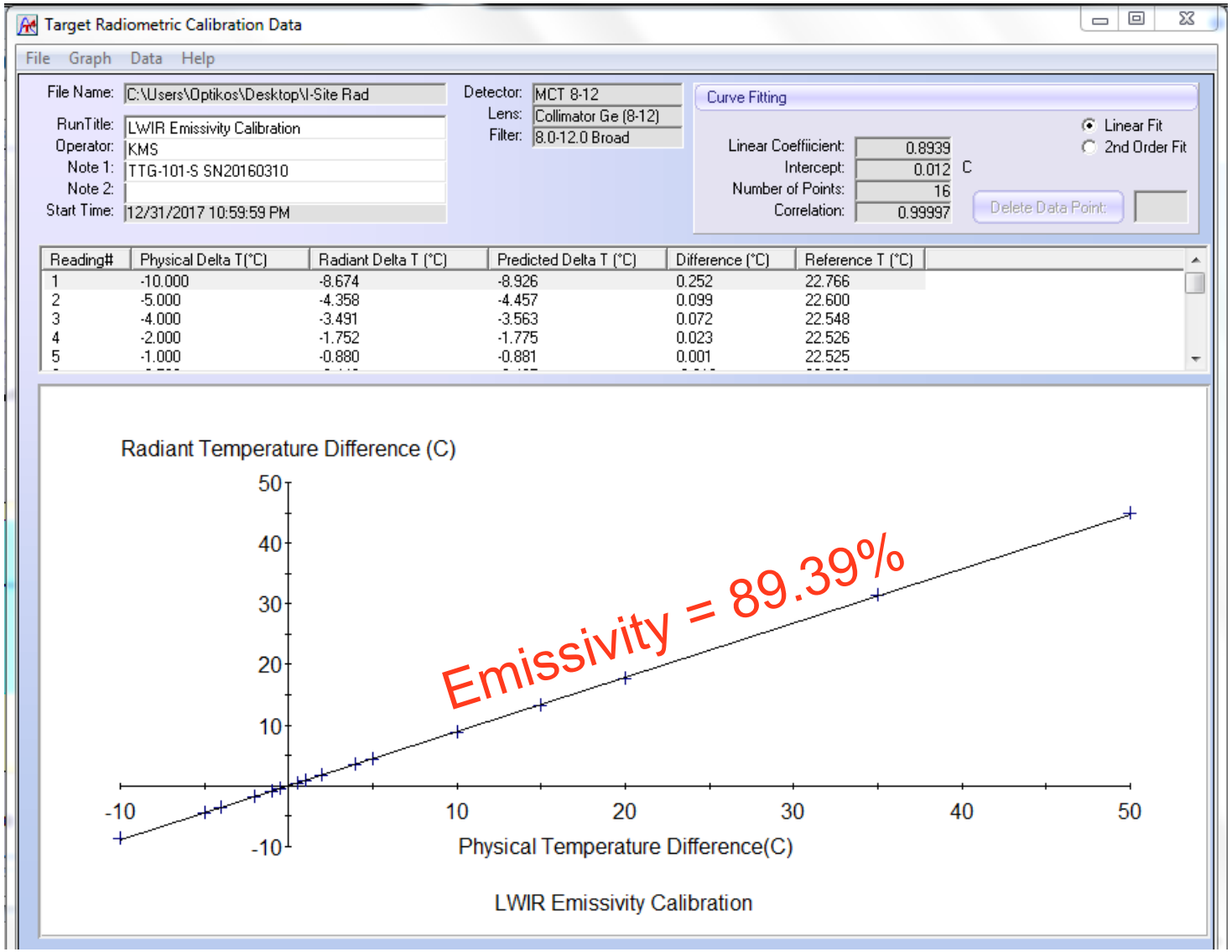
Bandpass Filter

Example Emissivity Calibration

- Perfect emissivity would produce a line with slope = 1

- By scanning radiometer, uniformity of source radiant temperature can be measured





How does camera hardware support ADAS?

Resolution
MTF

Sensitivity
NETD

Classify

Detect

Identify Pedestrian

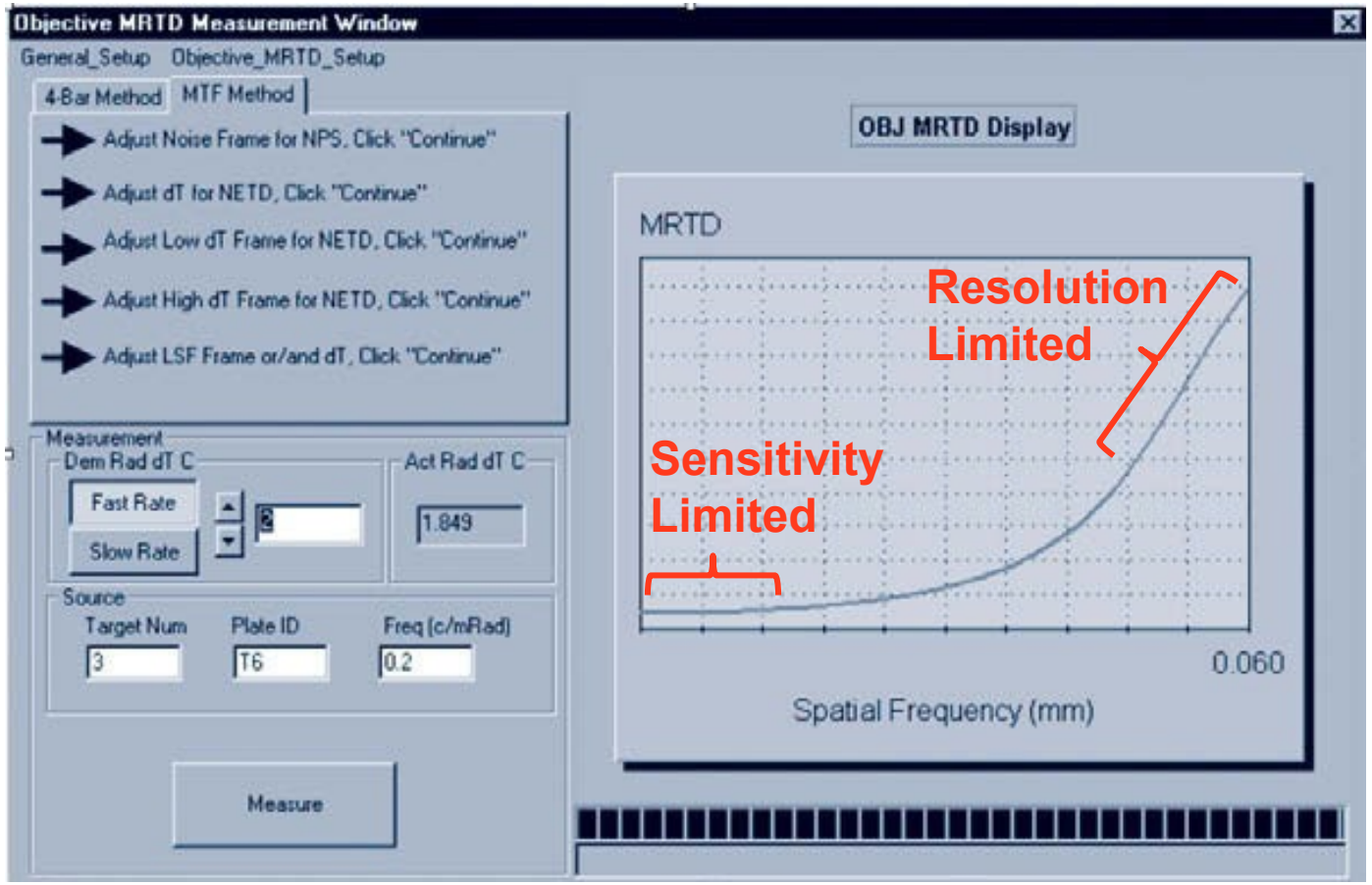
Composite KPI?

Minimum Resolvable Temperature Difference (MRTD)

MRTD combines resolution (MTF) with sensitivity and noise (NETD).

Increasing MRTD

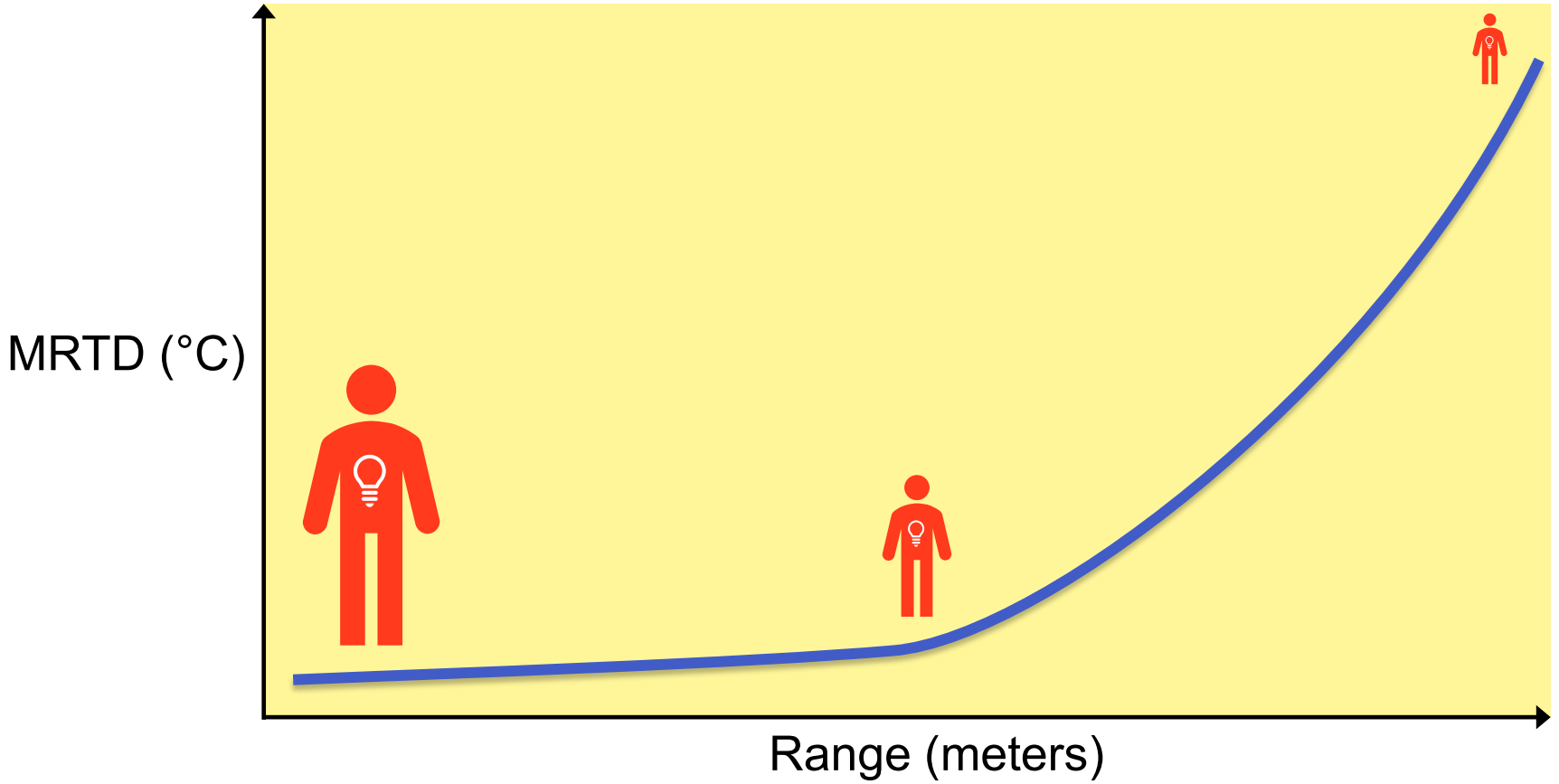
Larger temperature difference needed to resolve an object with size = $\frac{1}{\text{spatial frequency}}$



MRTD measurements from an Optikos I-SITE bench, circa 2003.

MRTD as a Composite KPI for CNN Pedestrian Identification

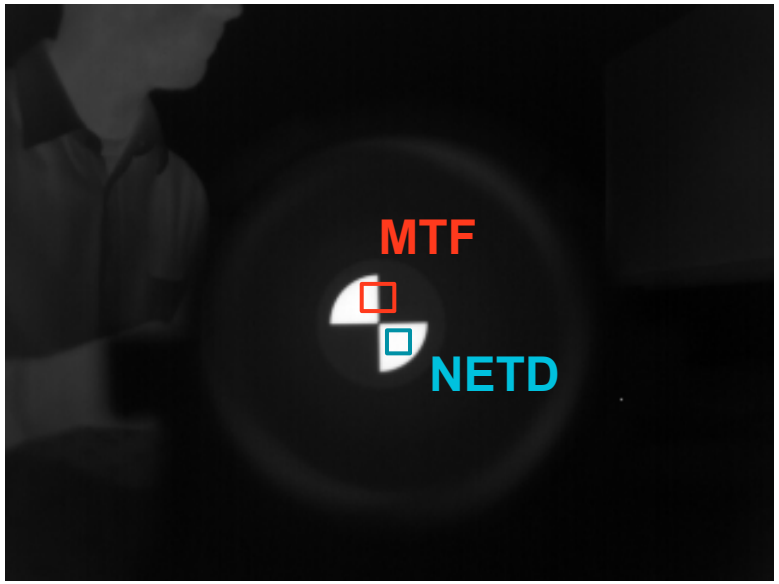
Recast horizontal axis as range:



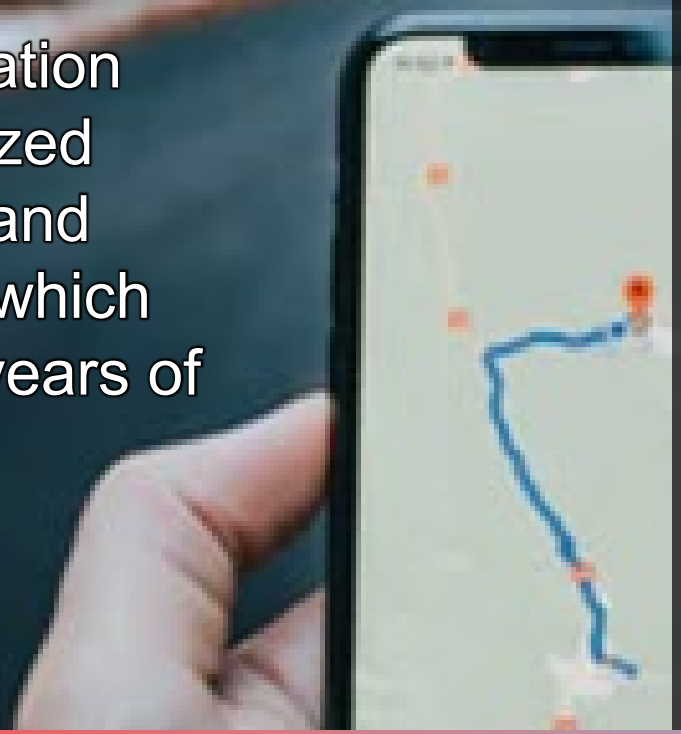
Correlate MRTD value at a particular range with perception efficacy in identifying pedestrians at that distance.

Thermal target projector requirements for MRTD

- 2X thermometers for temperature difference
- Situationally relevant temperatures
- Extended area, uniform source
  - With straight edges for MTF
- Compact for multifield testing
- ***Calibrated emissivity***



1. Composite KPIs that combine resolution and sensitivity will be critical tools for understanding the relationship between thermal camera image quality and AI perception.
2. Sensitivity measurements require emissivity calibration of the test source.
3. Emissivity calibration requires specialized instrumentation and techniques with which Optikos has 25 years of experience.



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