

# Modeling of Active Infrared Thermography for Defect Detection in Concrete Structures

B. Cannas<sup>1</sup>, S. Carcangiu<sup>\*1</sup>, G. Concu<sup>2</sup>, and N. Trulli<sup>3</sup>

1. Univ. of Cagliari, Electric and Electronic Eng. Dept., Piazza d'Armi, Cagliari, Italy, 09126

2. Univ. of Cagliari, Civil Eng., Environmental and Architecture Dept. , Piazza d'Armi, Cagliari, Italy, 09126

3. Univ. of Sassari, Architecture and Planning Dept., Piazza Duomo 6, Alghero, Italy, 07041

**Introduction:** Infrared Thermography (IRT) is an effective Non-Destructive Testing Technique for evaluating buildings condition, because it gives information with immediacy, rapidity and relatively low cost. The finite element method has been applied to simulate the problem of heat transfer on a concrete wall, built in laboratory, and analyzed with IRT, in order to detect the position of some artificial defects, including an internal cavity.

## Computational Methods:

The numerical model is implemented with the Heat Transfer Module.

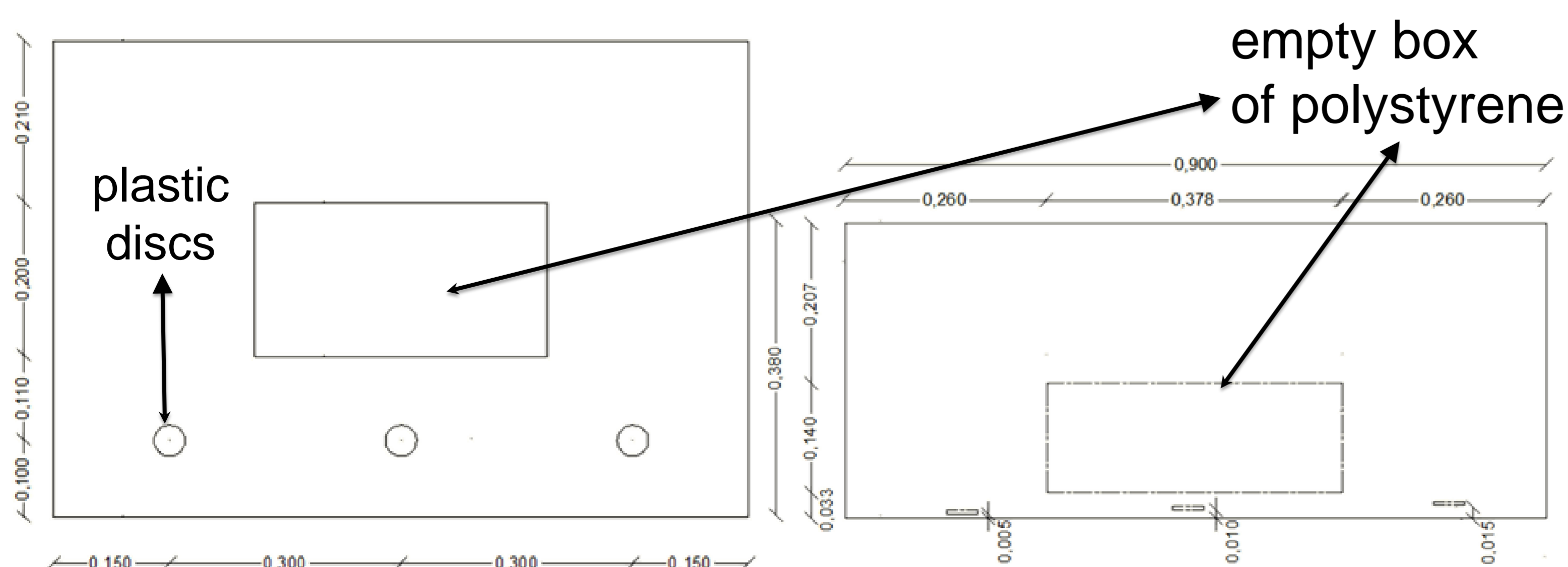
The heat sources are two solid objects of 1000W whose top faces the wall. The differential equation, governing pure conductive heat transfer is:

$$\rho C_p \frac{\partial T}{\partial t} - \nabla \cdot (k \nabla T) = 0;$$

$$T(x, y, z, t = 0) = T_{amb} = 293.15[\text{K}]$$

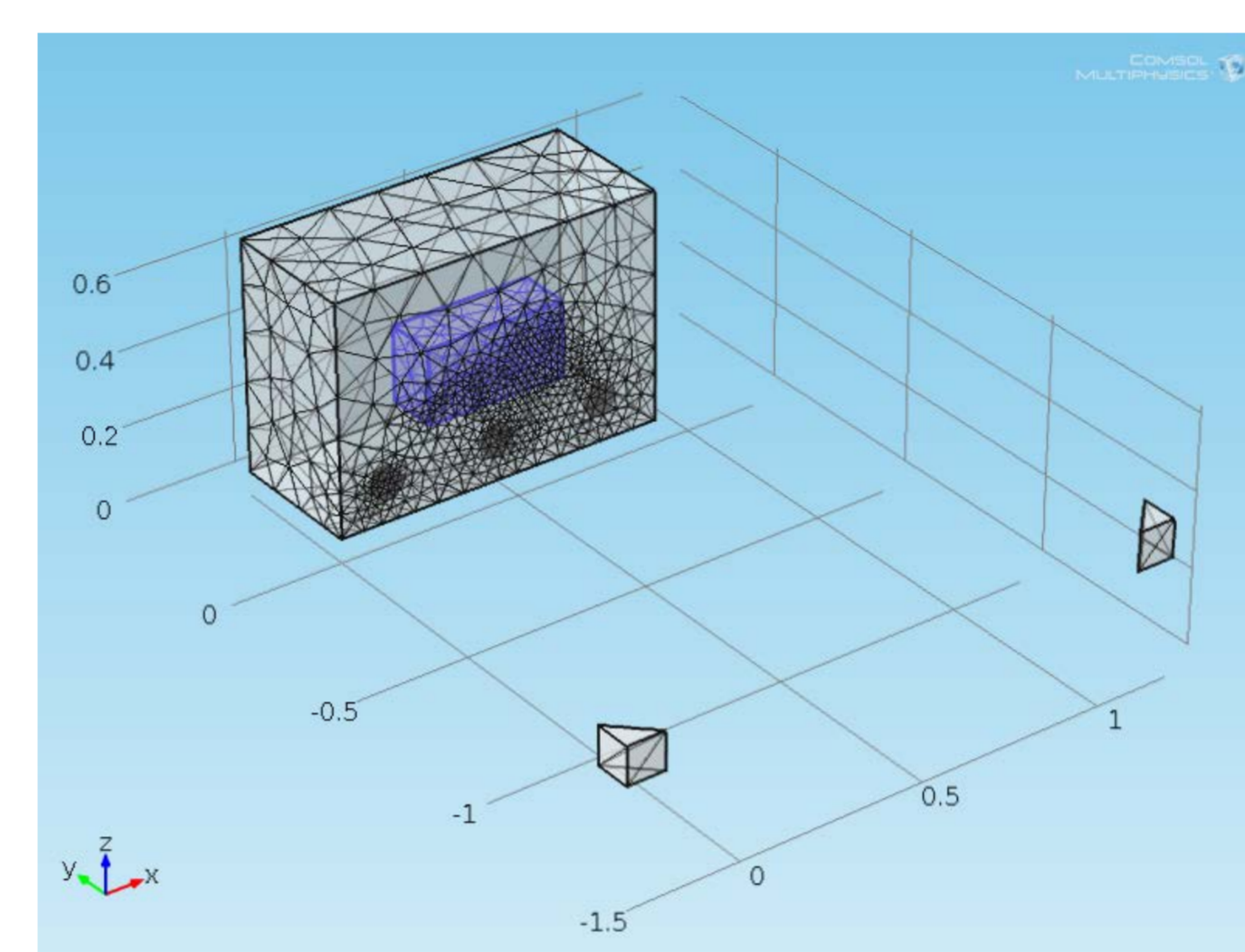
**Table 1.** Materials properties

	Plastic	Concrete	Halogen Lamps
<b>Thermal Conductivity <math>k</math></b> [W/(m·K)]	0.23	1.8	400
<b>Heat Capacity <math>C_p</math></b> [J/(Kg·K)]	1670	1000	10
<b>Surface Emissivity <math>\varepsilon</math></b>		0.92	0.99
<b>Density <math>\rho</math></b> [Kg/m <sup>3</sup> ]	1160	2300	8700

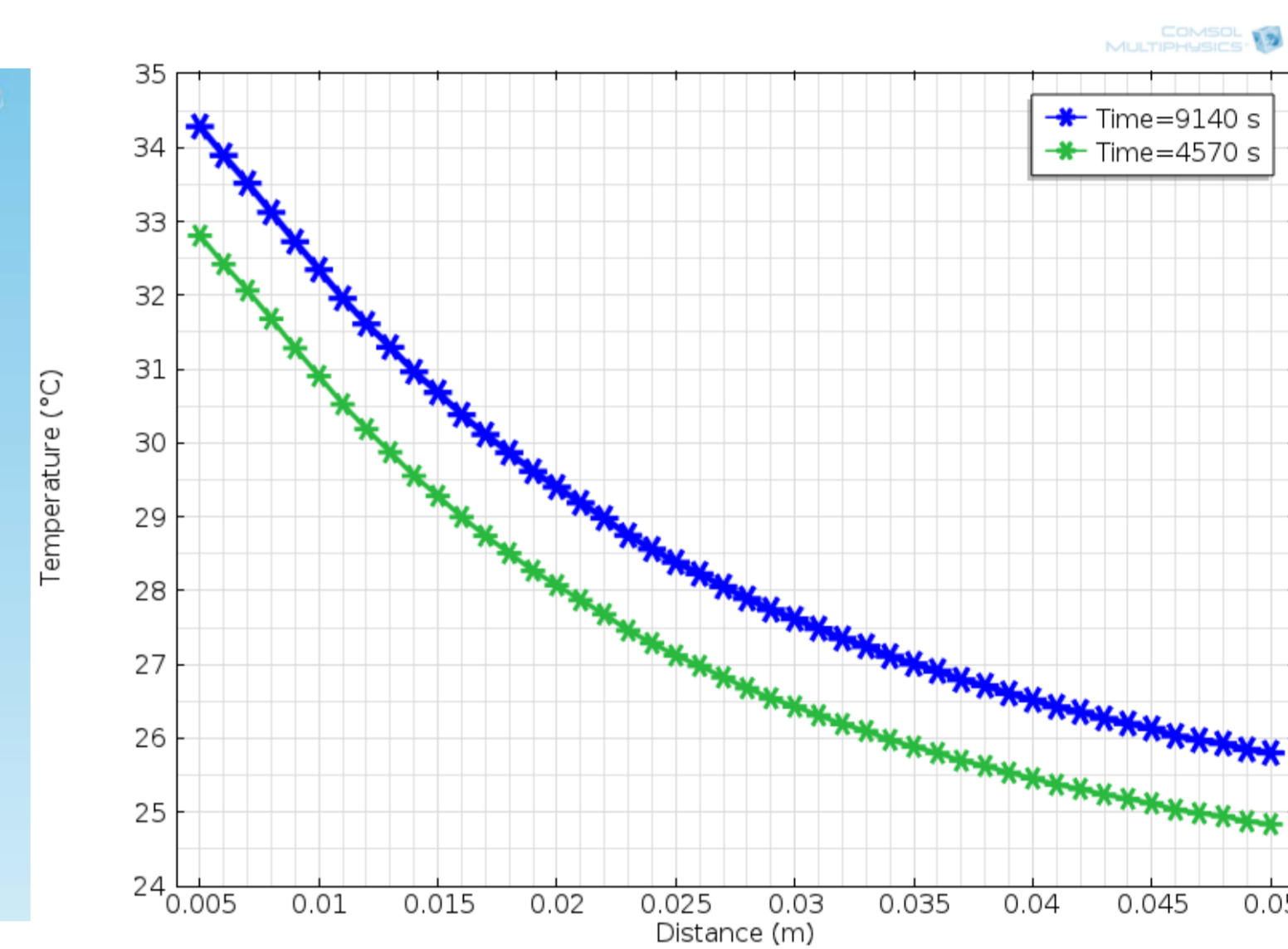


**Figure 1.** Front view and horizontal section of the concrete wall

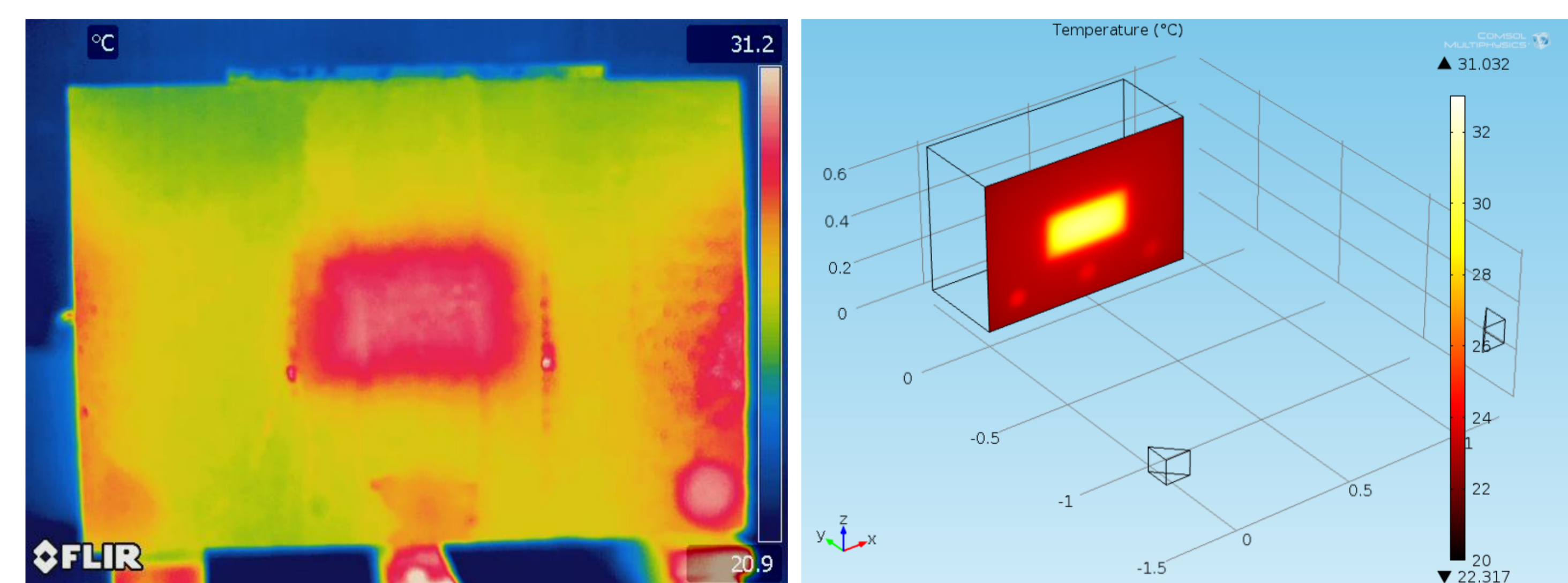
**Results:** A parametric analysis has been performed by varying the distance of the air cavity from the surface of the wall from 0.004m to 0.05m with step 0.001 m, with the aim of reproducing the experimental thermograms and identify the defect position.



**Figure 2.** Meshed 3D model: concrete wall with air cavity (blue) and plastic discs and two halogen lamps



**Figure 3.** Maximum temperature vs. distance of the air cavity from the surface



**Figure 4.** Experimental and simulated Thermograms after 4570 s (heating-up phase) with a distance of the air cavity from the surface of the wall equal to 0.009 m.

**Conclusions:** Numerical data well match with the laboratory results of infrared thermography tests and allow parametric studies freed from the experimental tests to be performed. The comparison of simulated and experimental thermograms allows the defect position to be identified.

**References:** C. Meola, A new approach for estimation of defects detection with infrared thermography, Mat. Lett., Vol. 61, pp. 747-750 (2007)