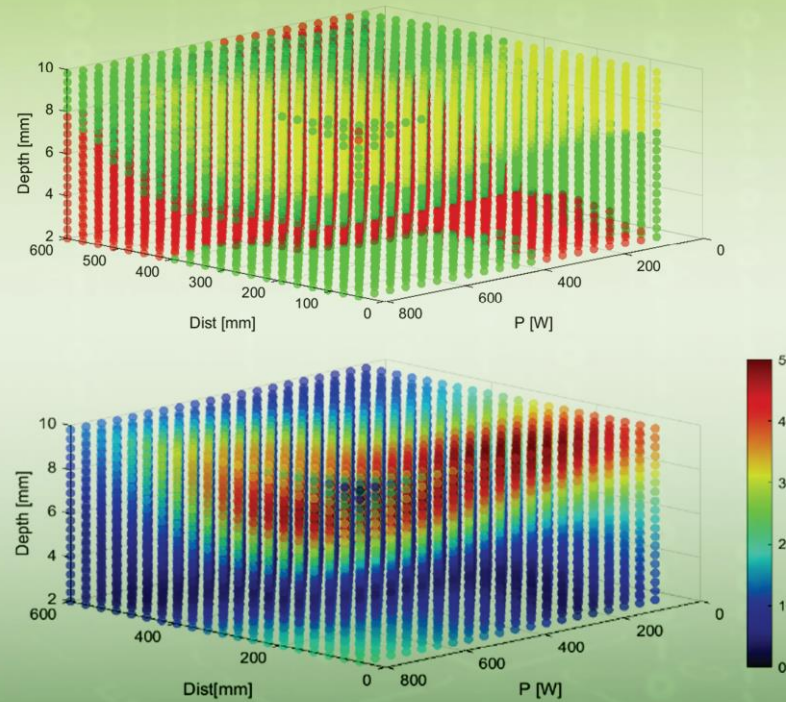
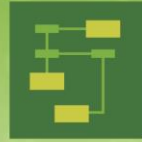


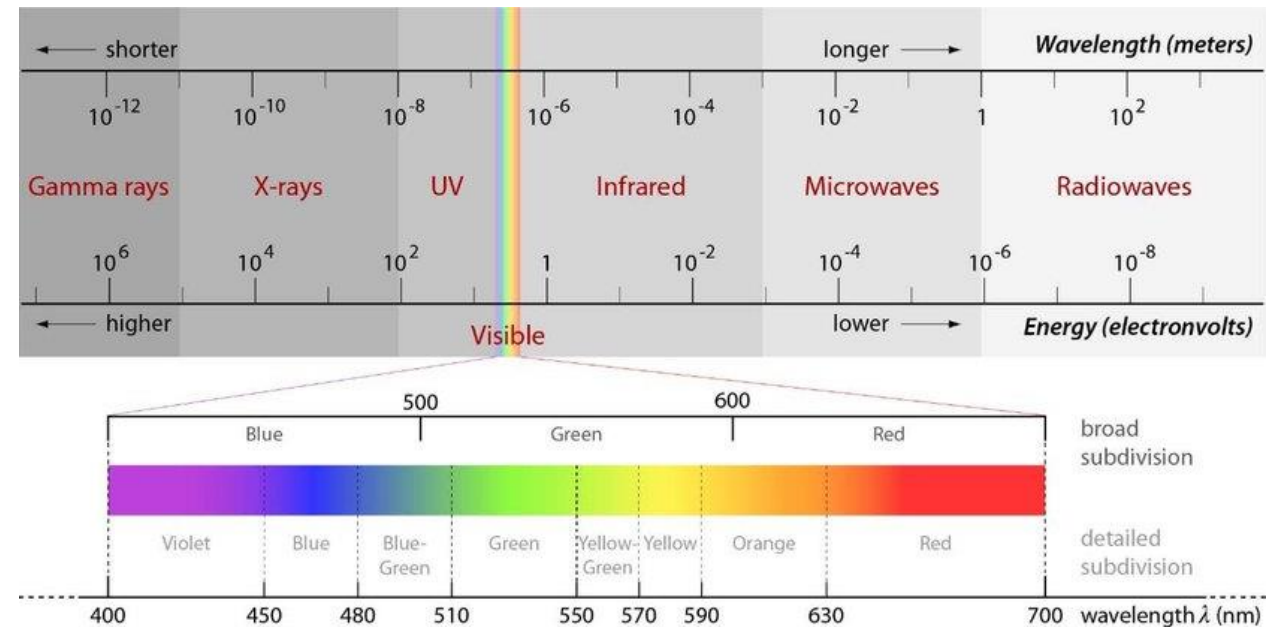
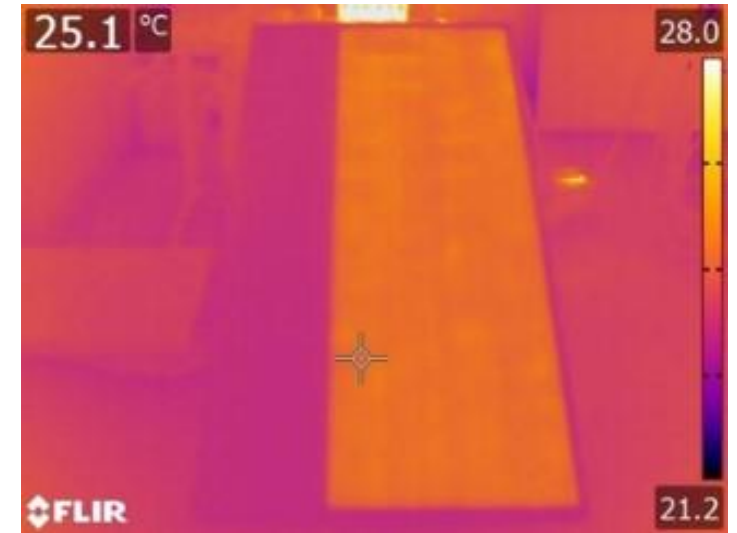


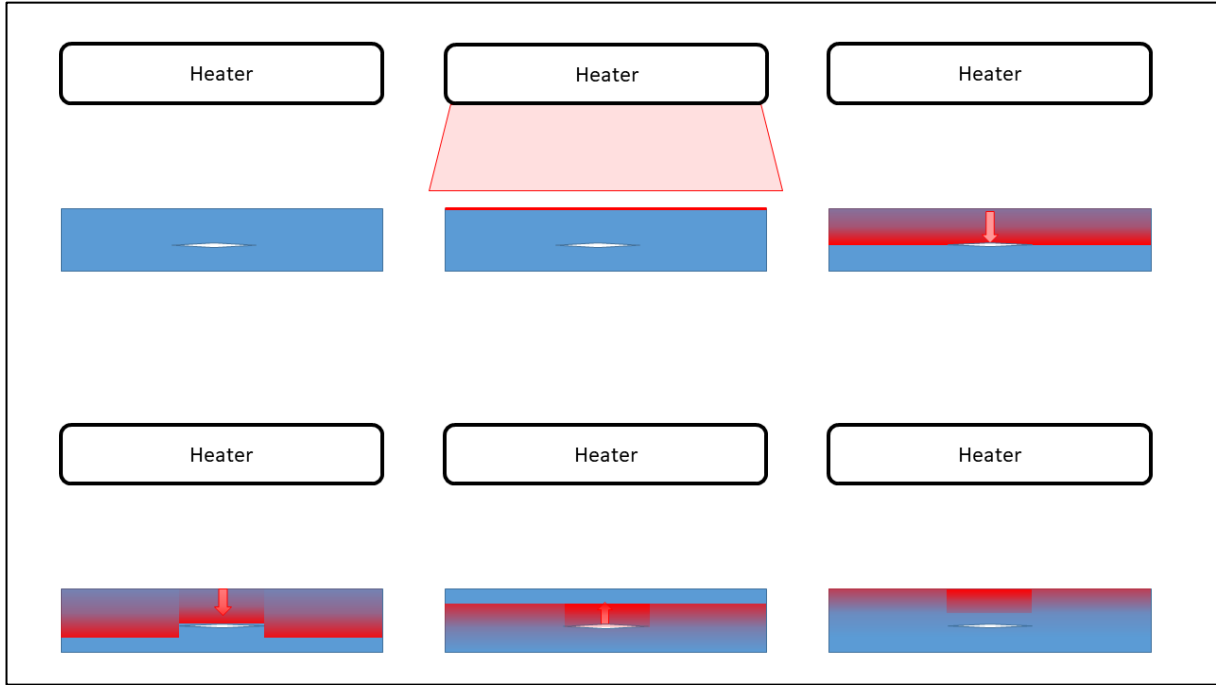
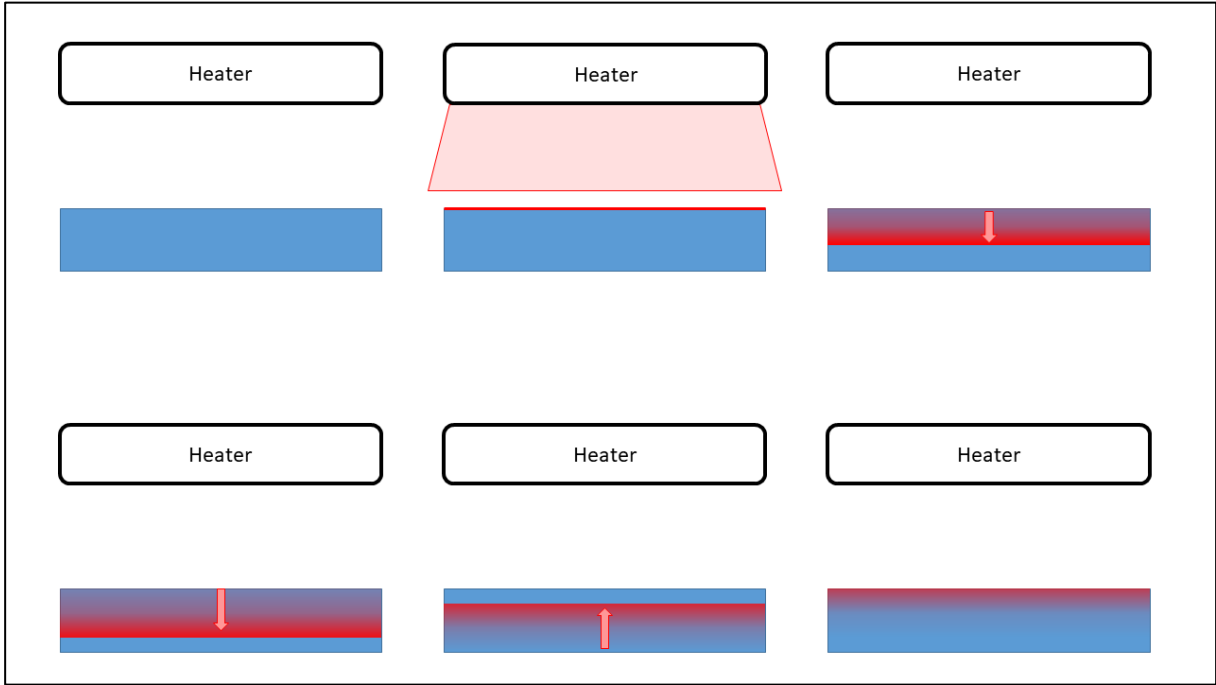
Thermography Parameter Design via Gaussian Process Emulation

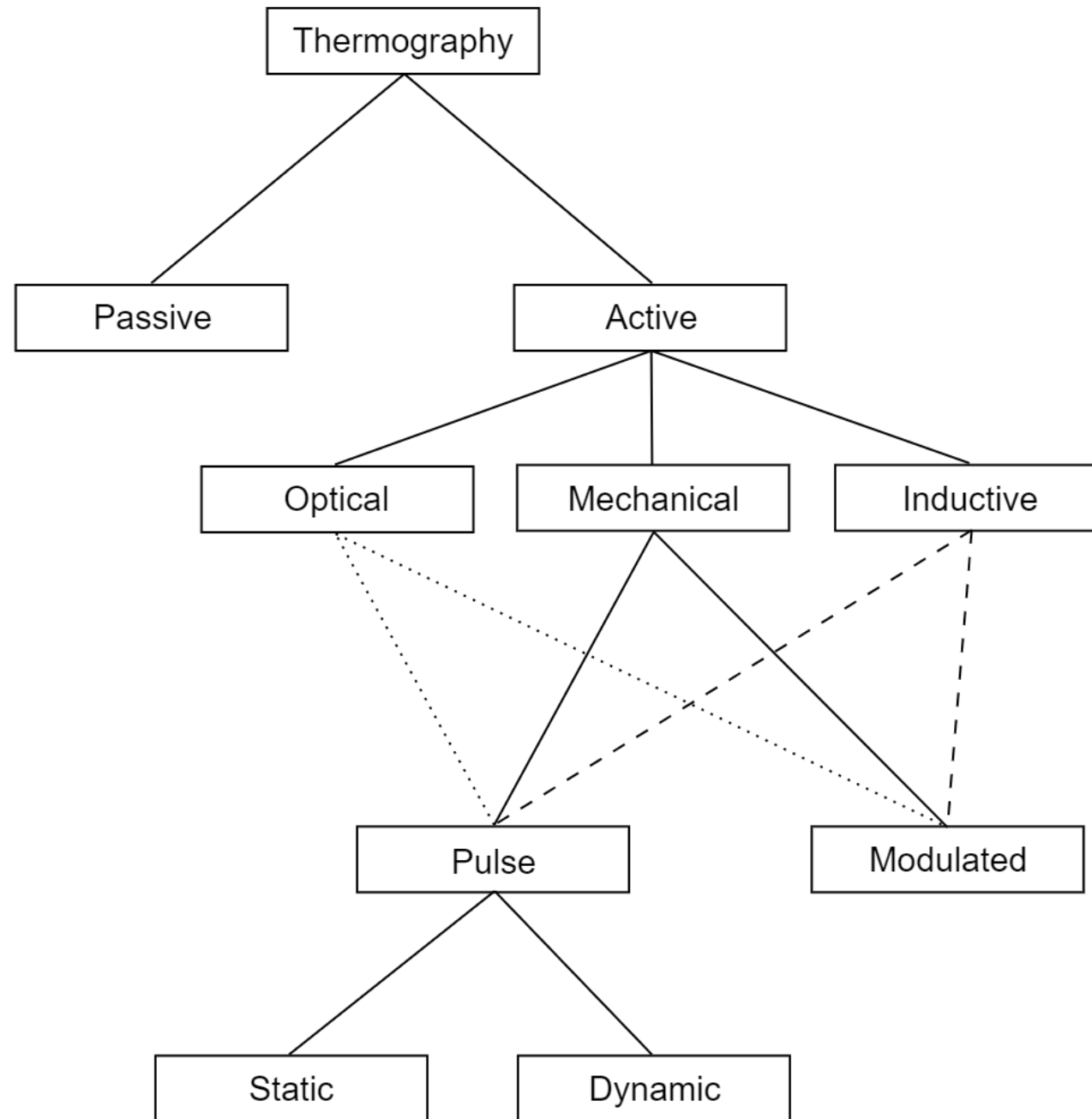
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Thermography

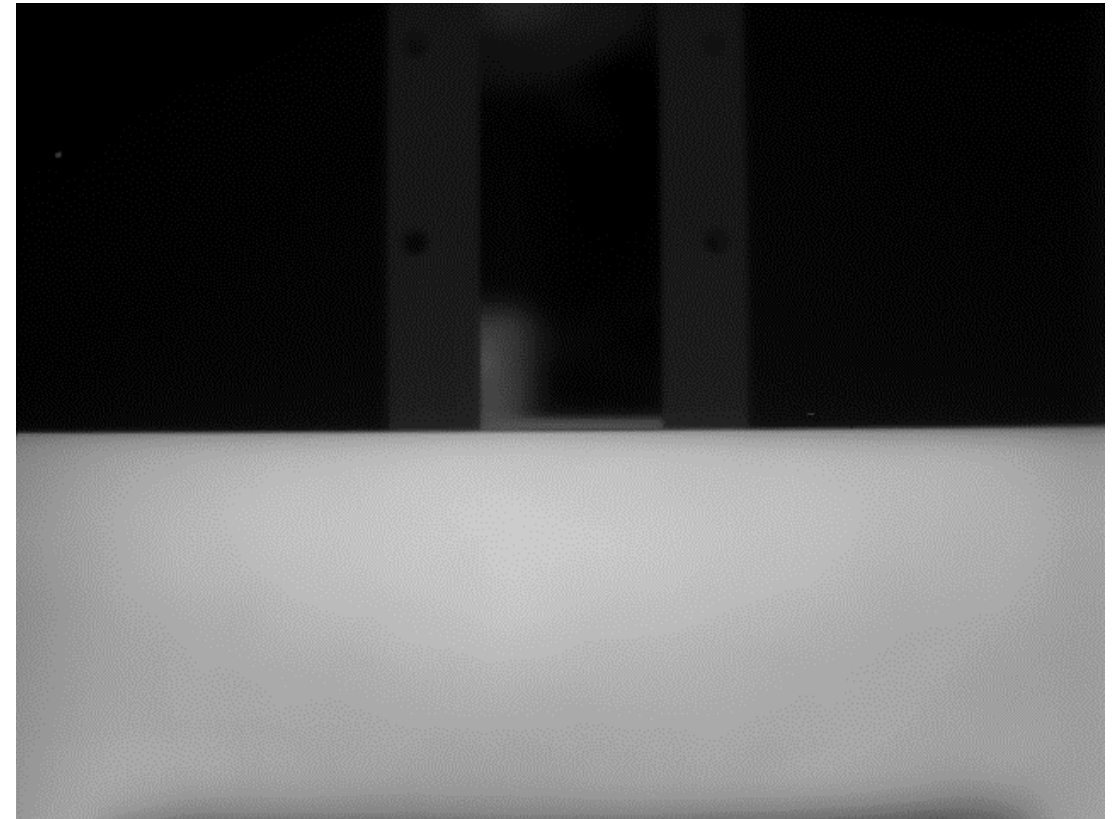
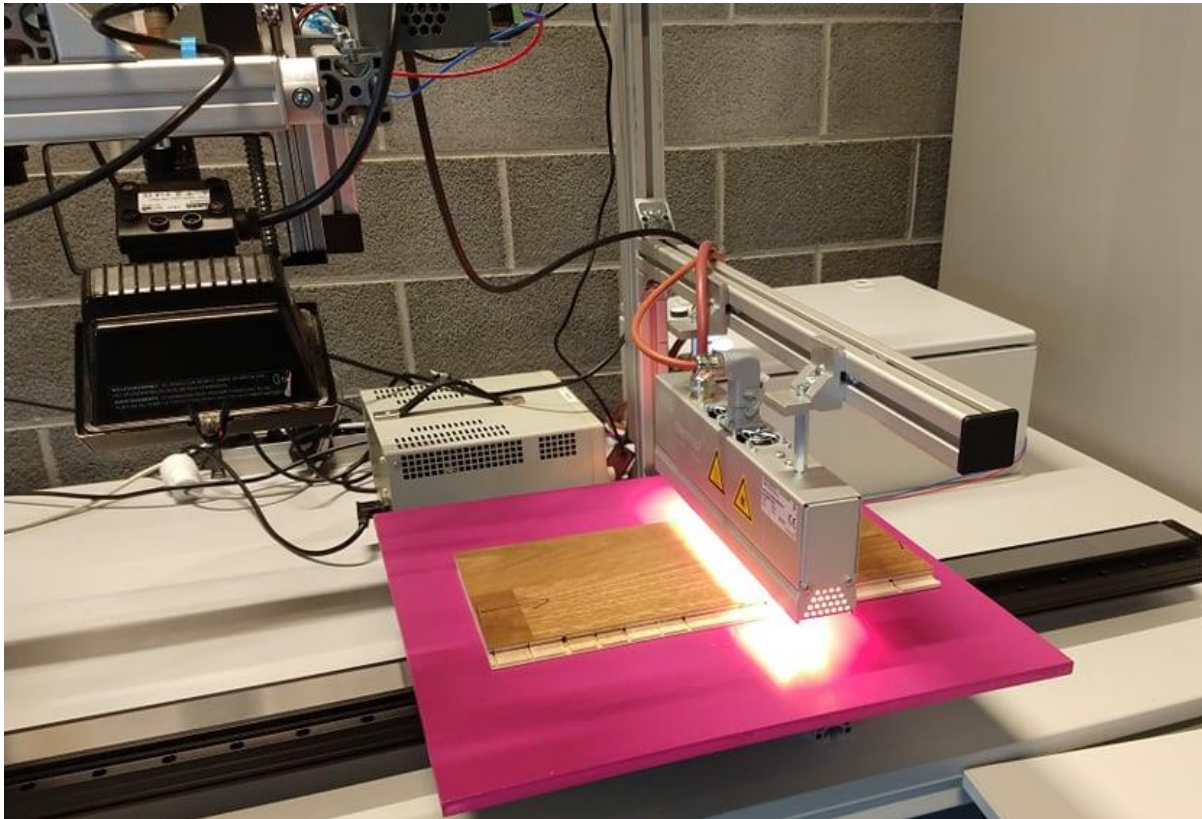
- Recording of infrared radiation
 - Emitted by every object above absolute zero (0K)



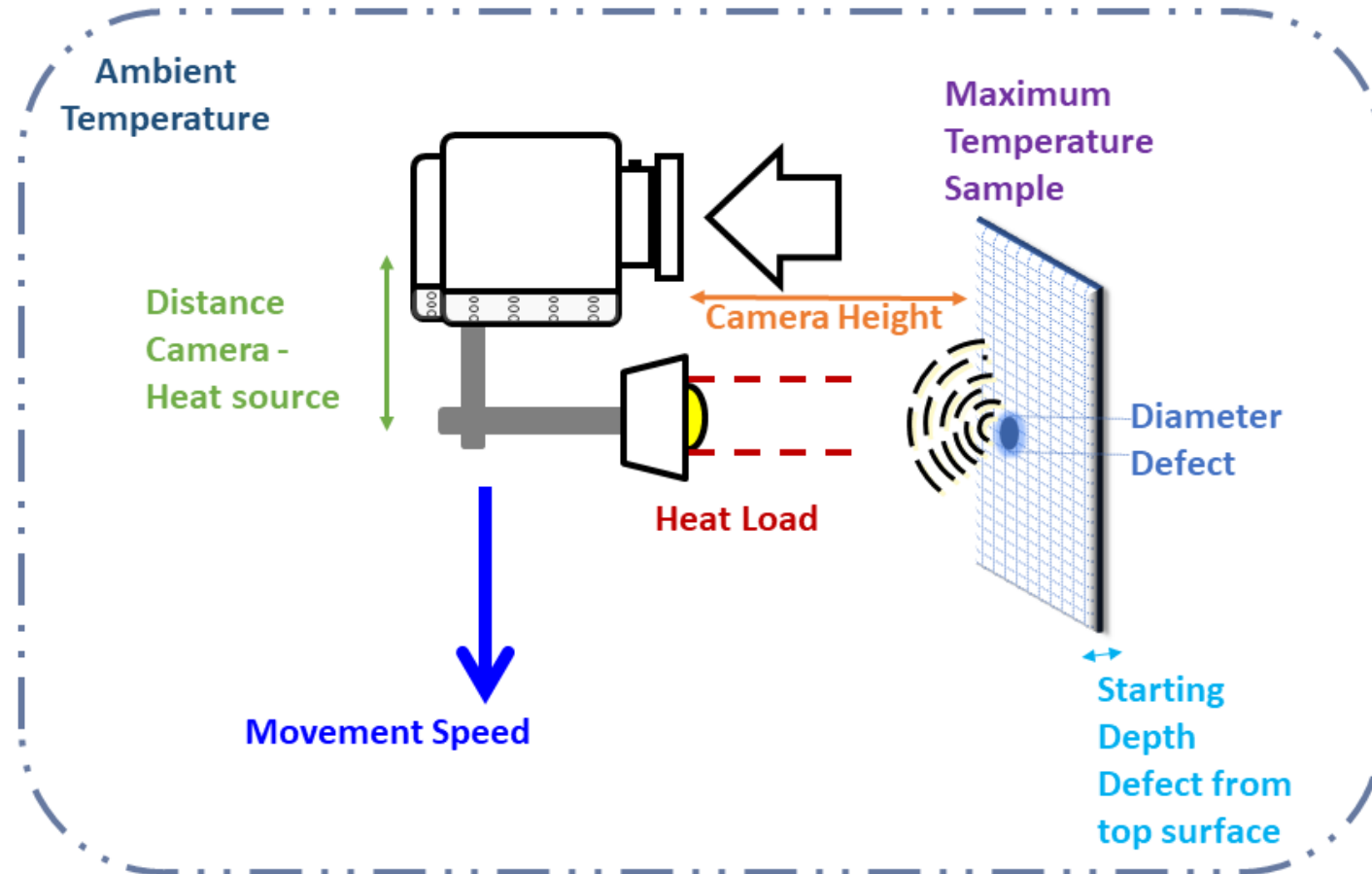




Dynamic Line Scan Thermography (DLST)



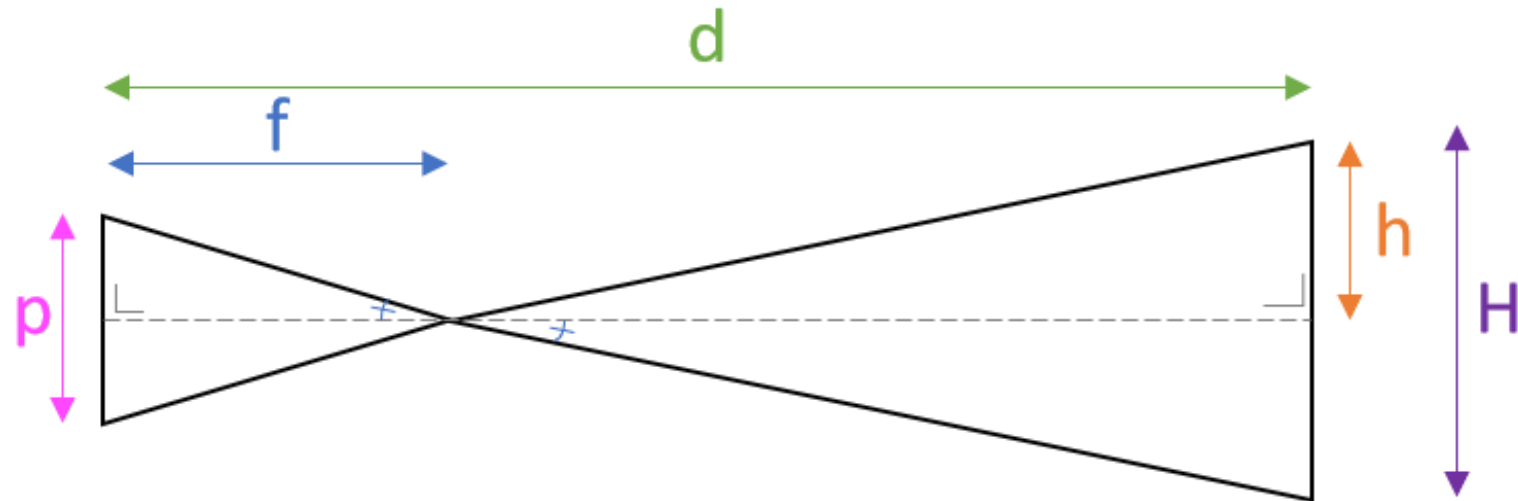
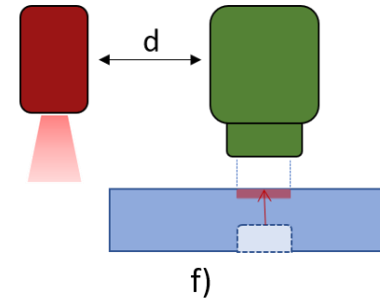
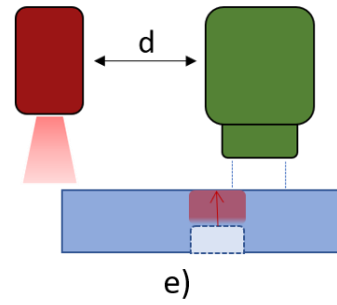
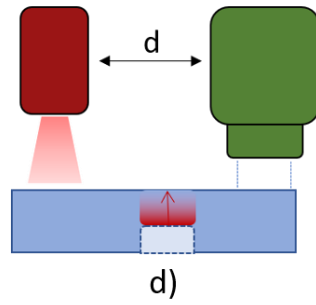
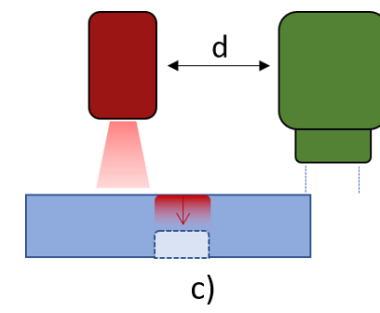
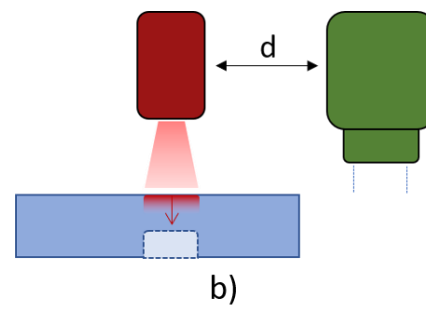
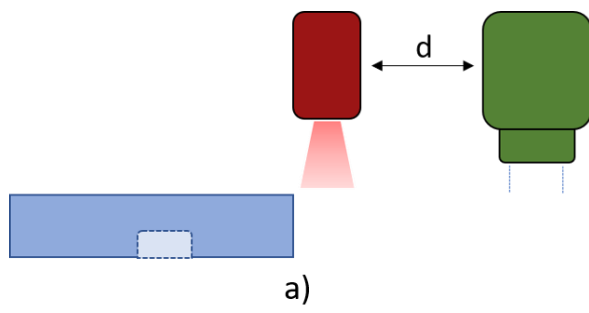
Dynamic Line Scan Thermography (DLST)



Parameters

- Defect diameter: 6 – 50mm
- Defect starting depth: 0,1 – 9mm
- Heat load: 50 – 1000W
- Source velocity: 5 – 20mm/s
- Distance heat source and camera: 50 – 600mm
- Height thermal camera: 150 – 600mm
- Ambient temperature: 20 – 40°C

- Temperature difference: $\geq 1^{\circ}\text{C}$



Response surface

- 1000 simulations
- Predict optimal parameter:

Defect diameter: 12mm

Defect starting depth: 7,5mm

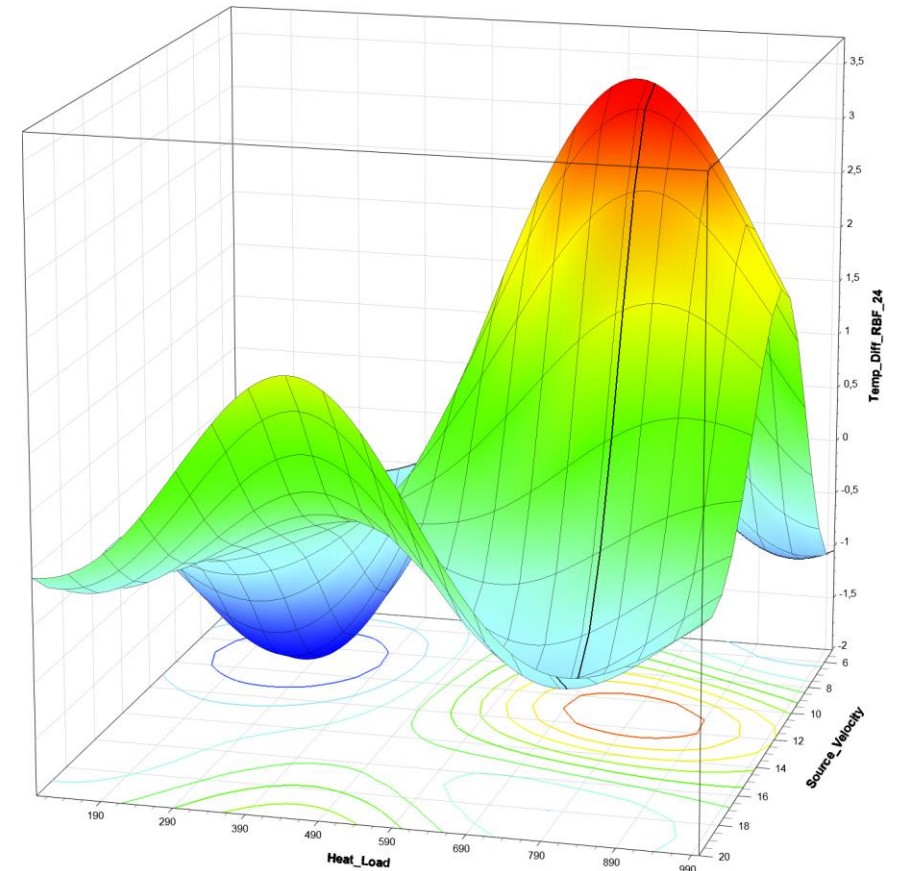
Heat load: 800W

Source velocity: 5mm/s

Distance heat source and camera: 50mm

Height thermal camera: 300mm

Ambient temperature: 22°C

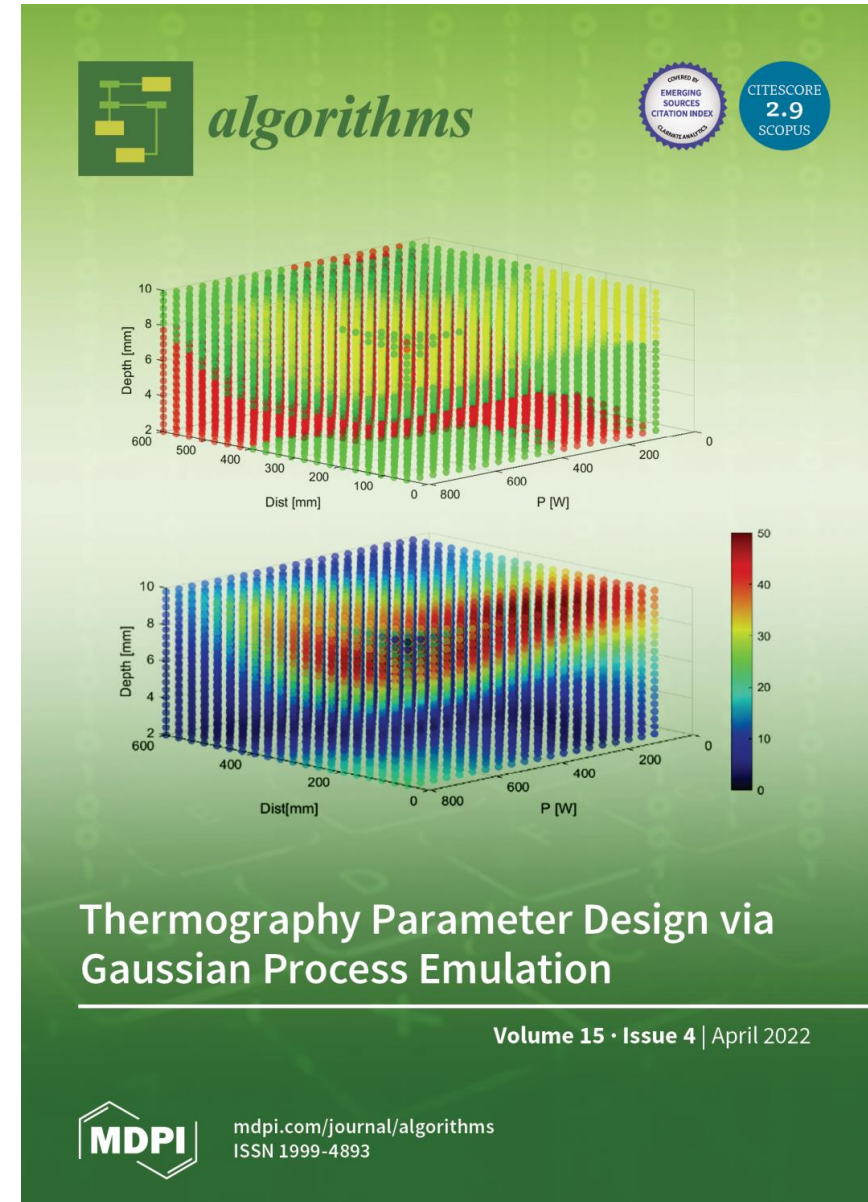


Gaussian process emulation

- Limit amount of needed simulations
- Provide additional information

Fixed parameters:

- Movement velocity: 10mm/s
- Camera height: 450mm
- Ambient temperature: 20°C



Example 1:

Parameter combination for specified defect with minimal heating?

Fixed input parameters:

Movement velocity: 10mm/s

Camera height: 450mm

Ambient temperature: 20°C

Requirements:

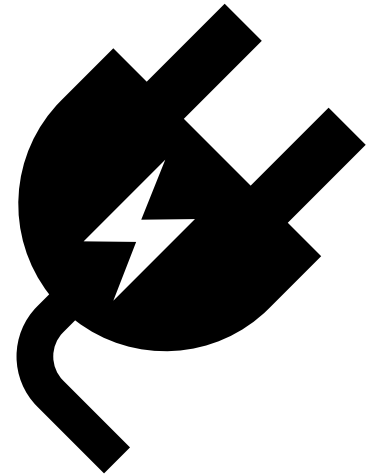
Temperature difference: 5 – 10°C

Objective:

Minimize heating power

50W → distance heat source and camera: 335 – 420mm

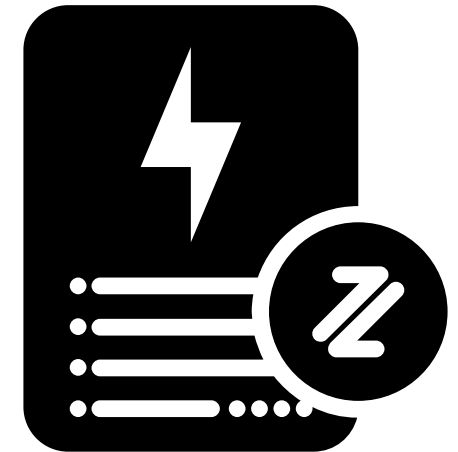
Smaller distance → 75W



Example 2:

Parameter combination to detect defects by only adjusting power?

- Fixed input parameters:
 - Movement velocity: 10mm/s
 - Camera height: 450mm
 - Ambient temperature: 20°C
 - Distance between heating source and camera: 100mm
- Requirements:
 - Detect range of defects
- Objective:
 - Only change heating power → $\geq 500\text{W}$



Example 3:

What regions of design space are dangerous?

Fixed input parameters:

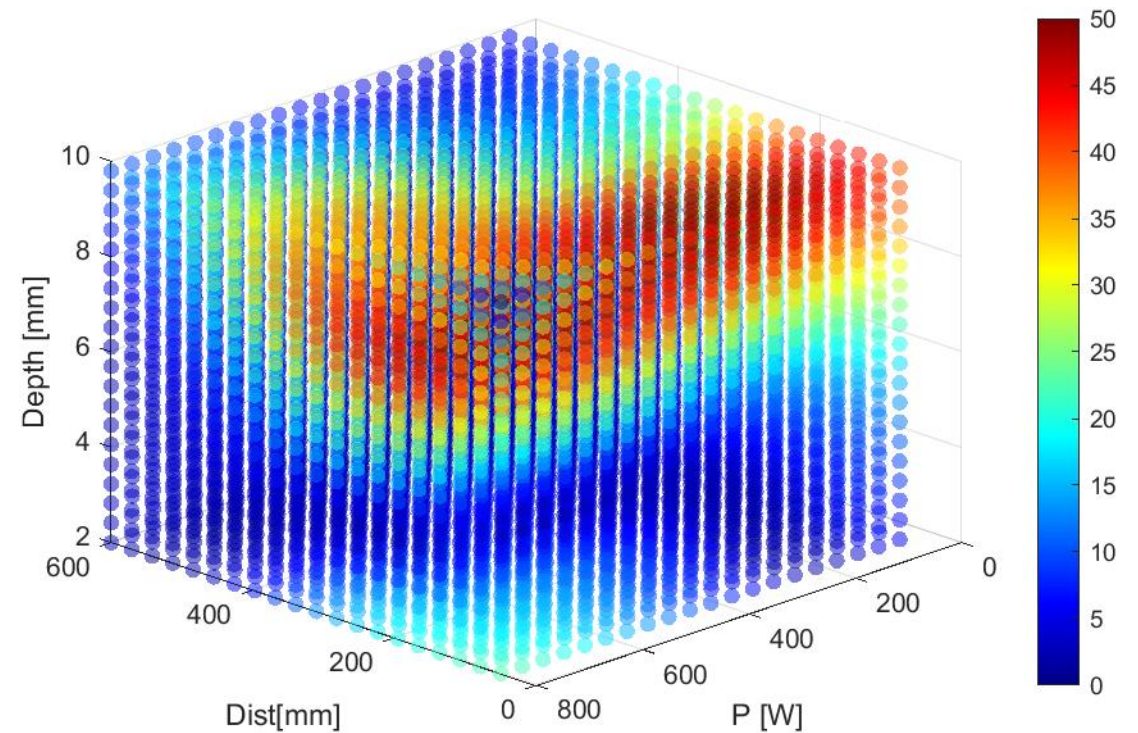
Movement velocity: 10mm/s

Camera height: 450mm

Ambient temperature: 20°C

Objective:

Visualize dangerous regions



Example 4:

What regions of design space result in enough temperature difference?

Fixed input parameters:

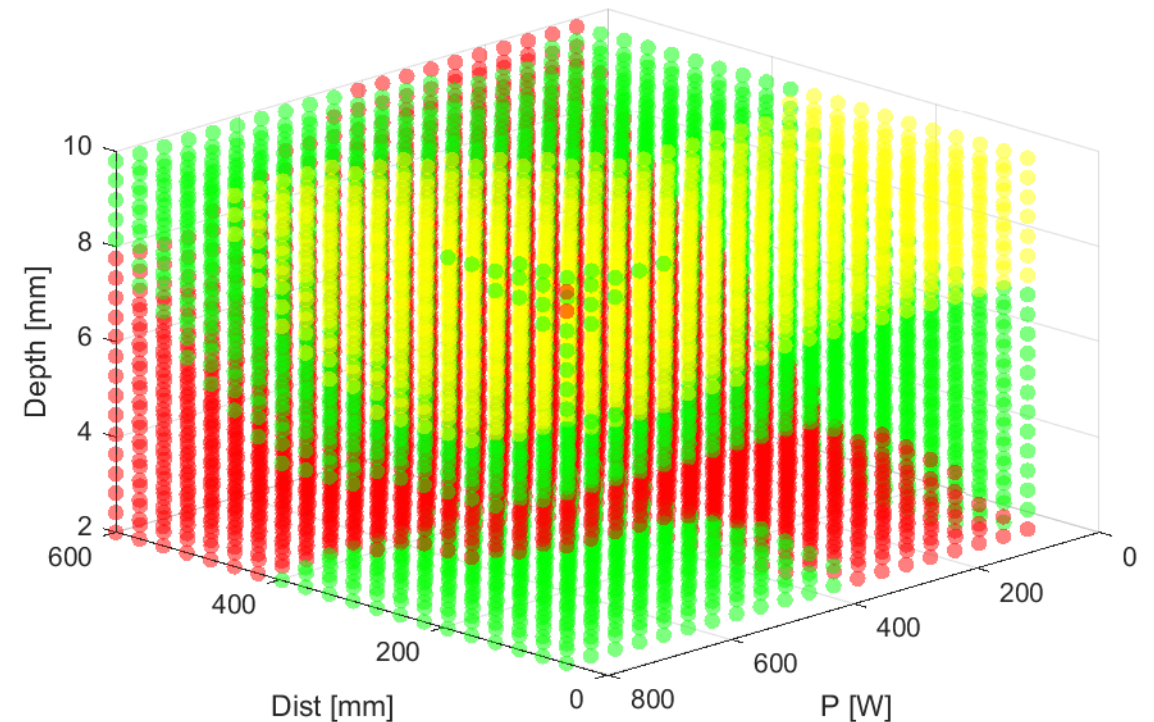
Movement velocity: 10mm/s

Camera height: 450mm

Ambient temperature: 20°C

Objective:

Visualize appropriate regions



Summary

When?

- Multi-dimension design space
- No obvious connection between parameters

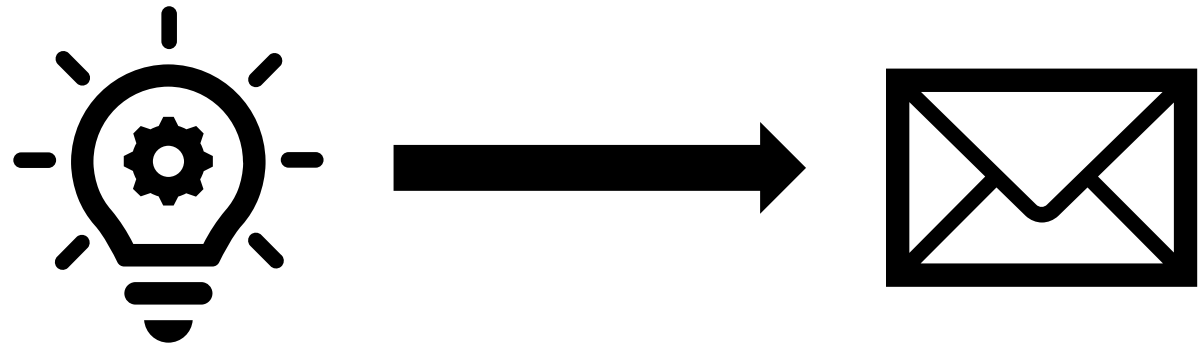
Why?

- Less simulations needed
- Answers to relevant industrial questions



Reach out!

- Questions?
- Collaborations!



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