Modelling Water Immersion Thawing Of Raw Tuna Fishes

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COMSOL CONFERENCE 2018 LAUSANNE

Thawing of large tuna fishes for the canning industry

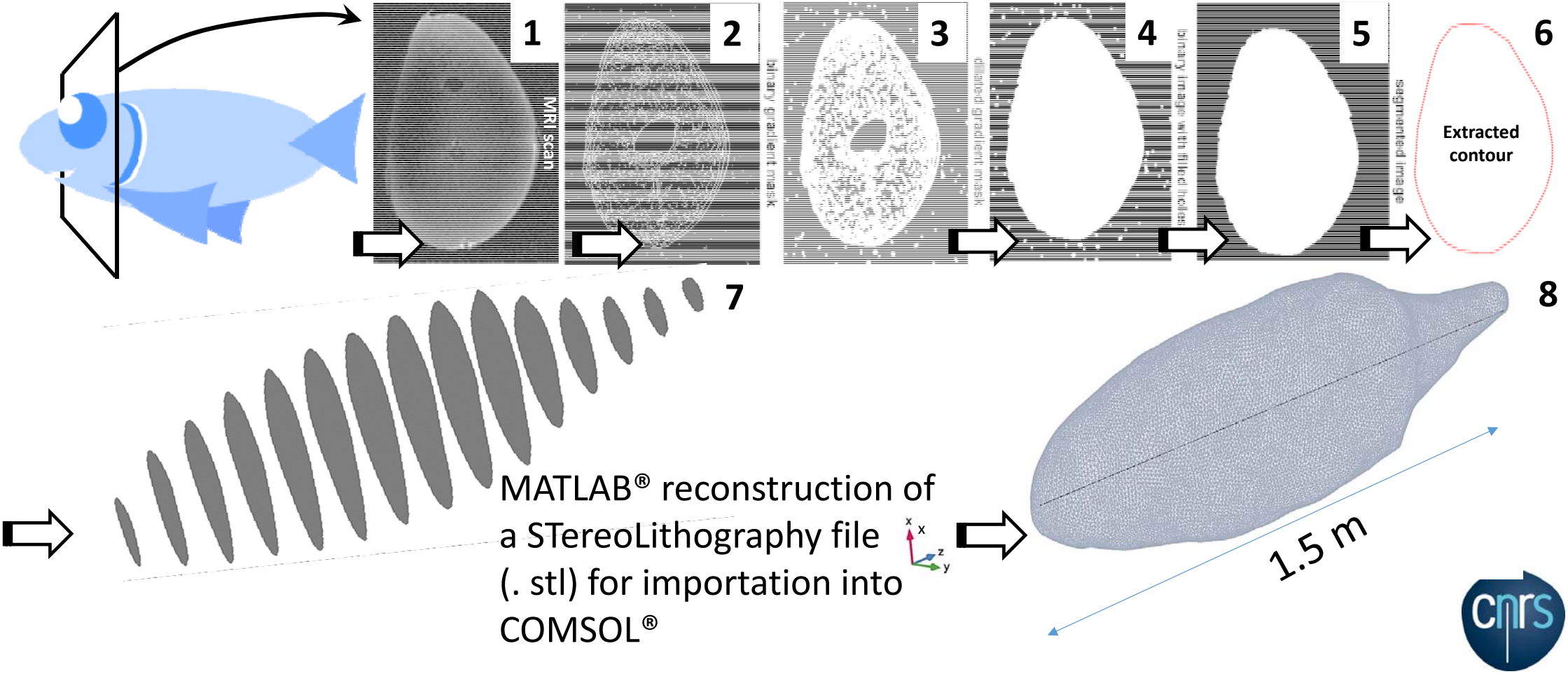
- energy-hungry industrial process (air or water immersion techniques)
- Long thawing times
- Thermal heterogeneities (core vs. surface)

Need to predict accurately the temperature distribution inside the product (hot and cold spots)

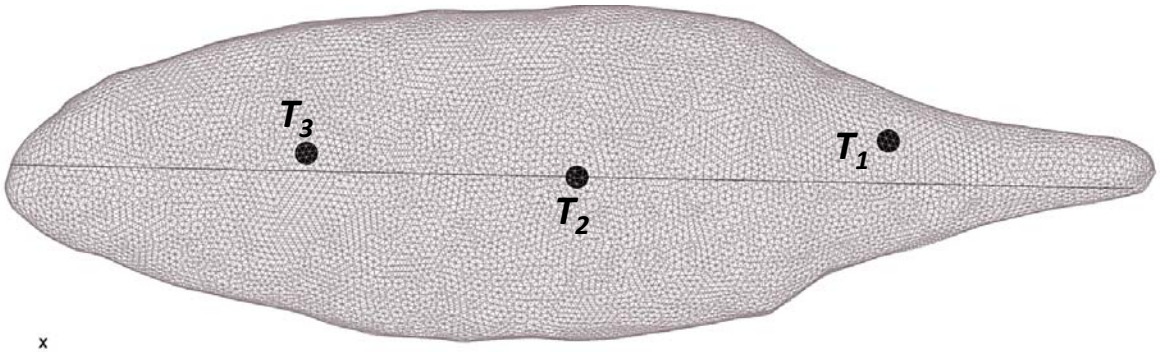
=> Ensuring microbial safety

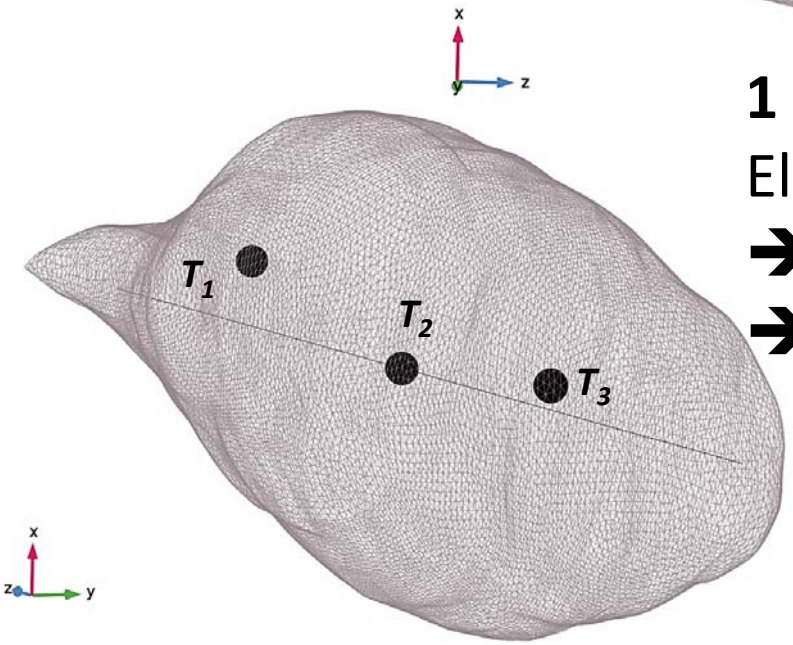
=> Reduction of fluid and energy consumption

MRI scans and image processing for COMSOL® modelling



Mesh generation



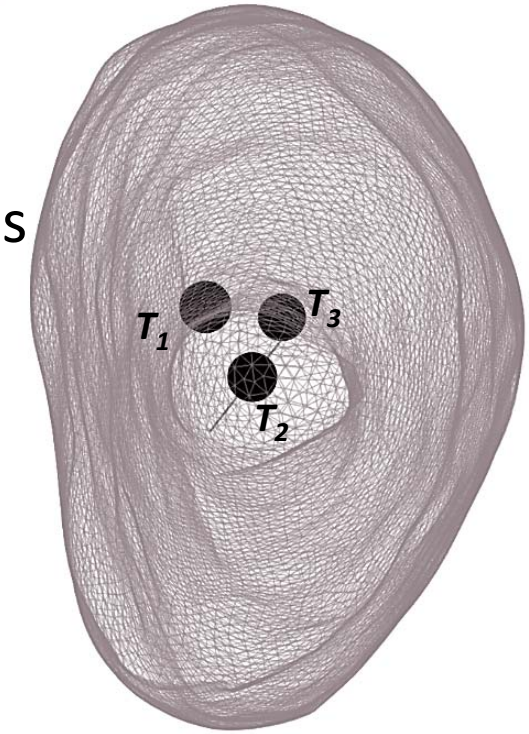


1 312 939 tetrahedral elements

Element sizes

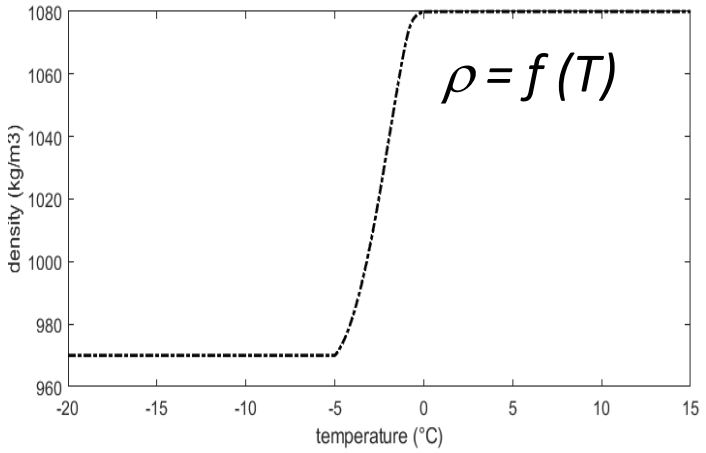
➔2.25 mm min.

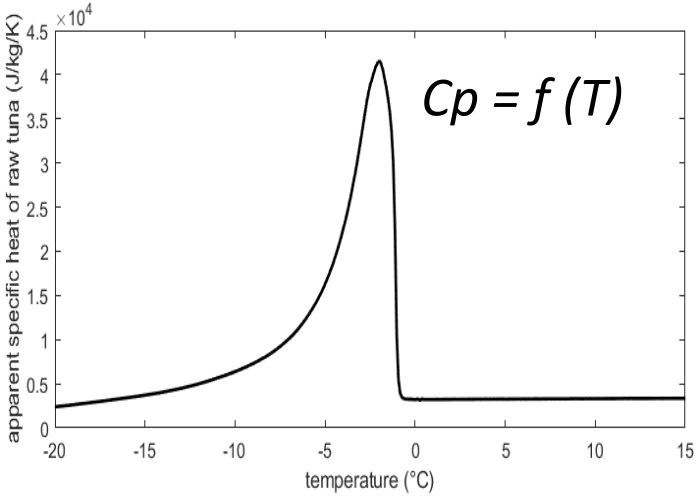
➔10 mm max.

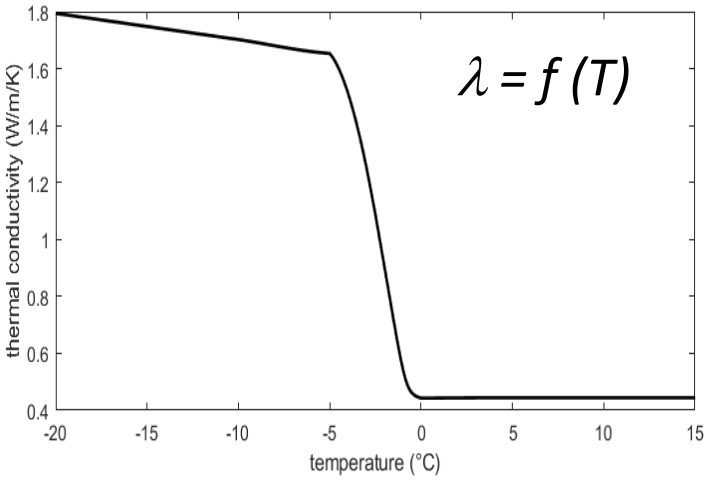


Modelling heat transfer during thawing:
Apparent specific heat approach

$$\rho(T)Cp_{app}(T)\ \frac{\partial T}{\partial t} = \nabla.(\lambda(T)\nabla T)$$





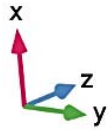


Boundary condition

$$-\vec{n}(-\lambda\nabla T) = -h(T - T_{ext})$$

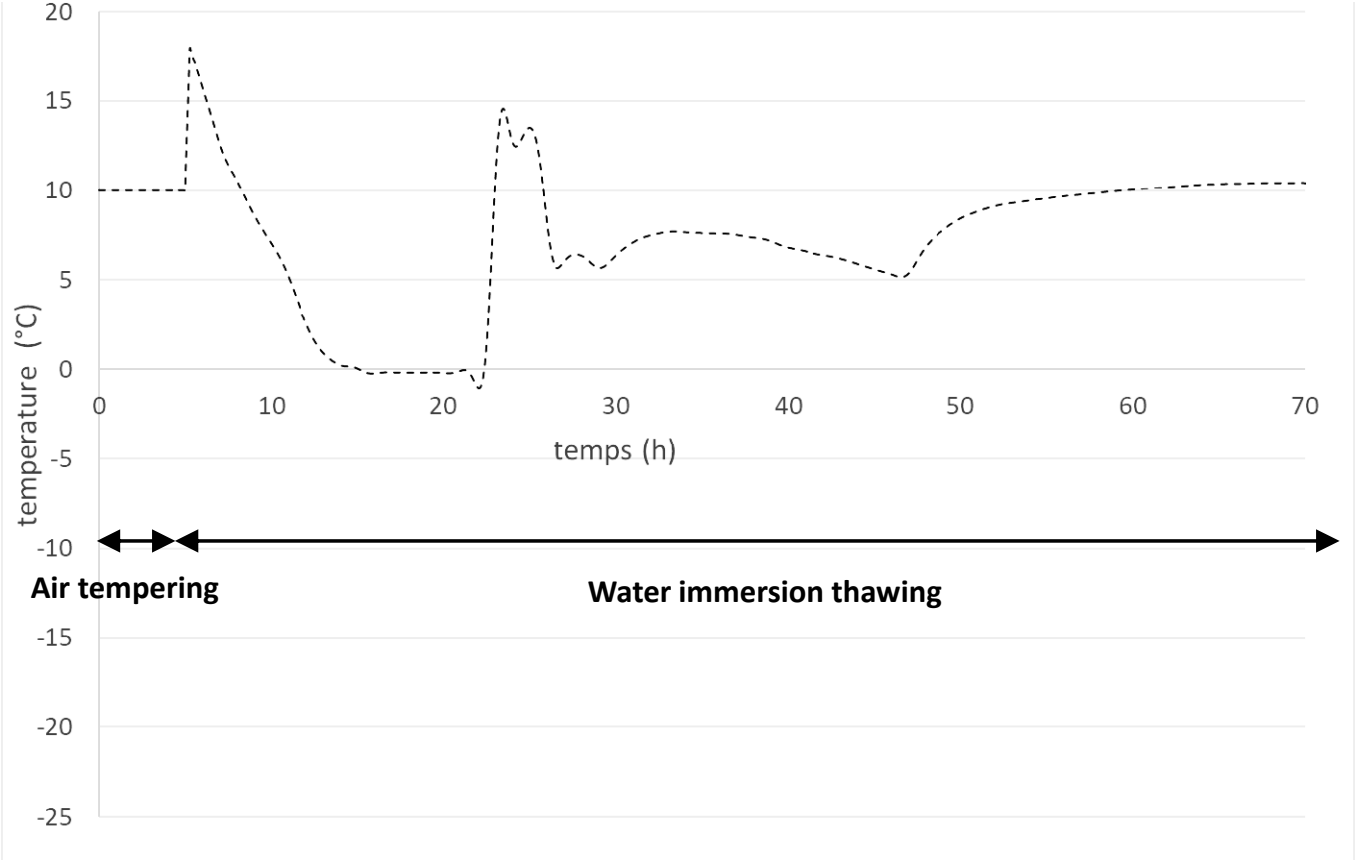
➔ Uniform heat transfer coefficient (h) around the external surface of the product

➔ Time-varying external temperature of the fluid

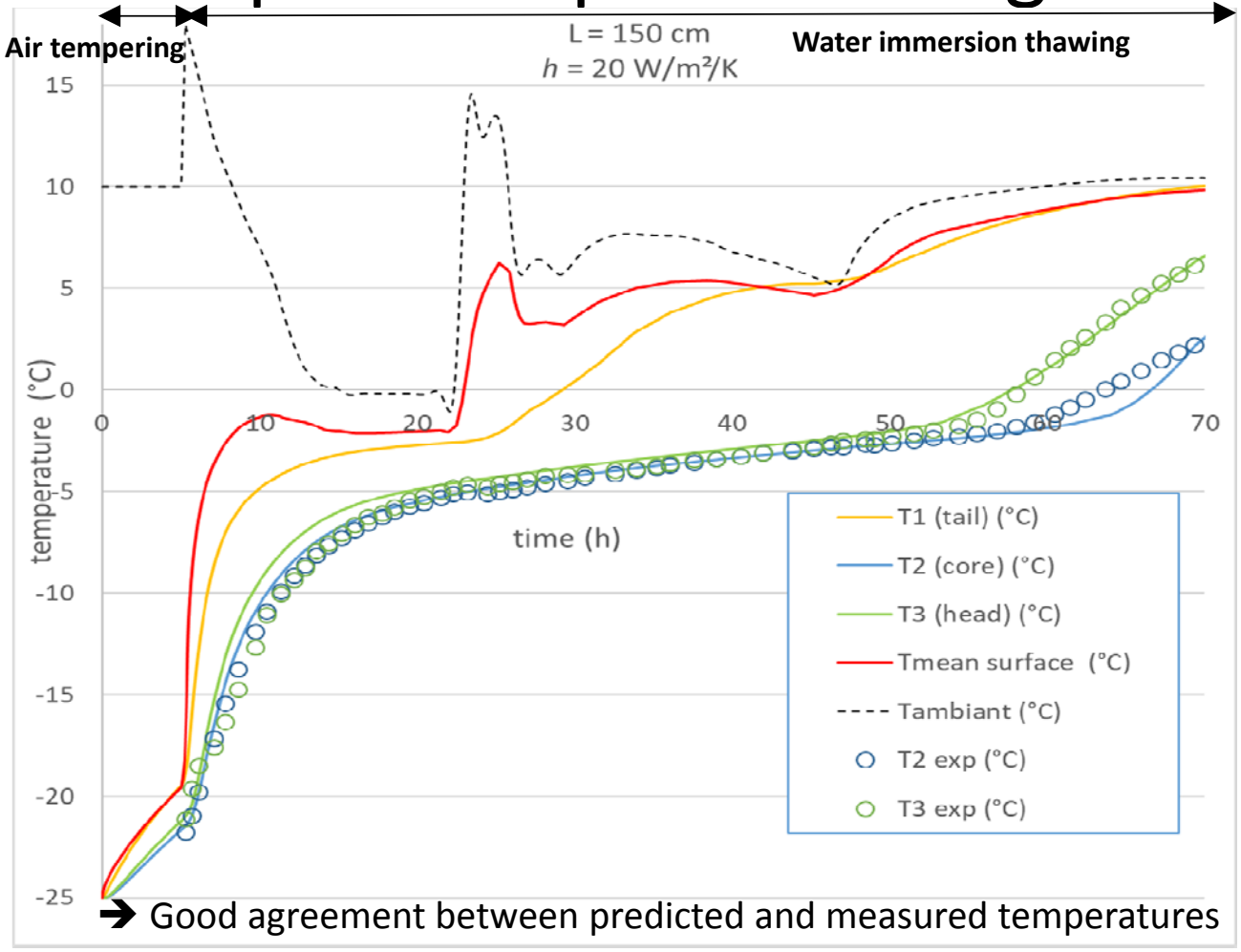


Boundary condition

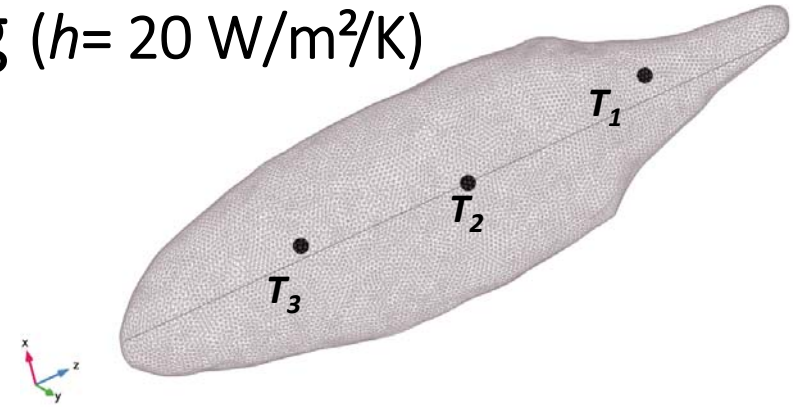
- Time-varying external temperature of the fluid (air and water)

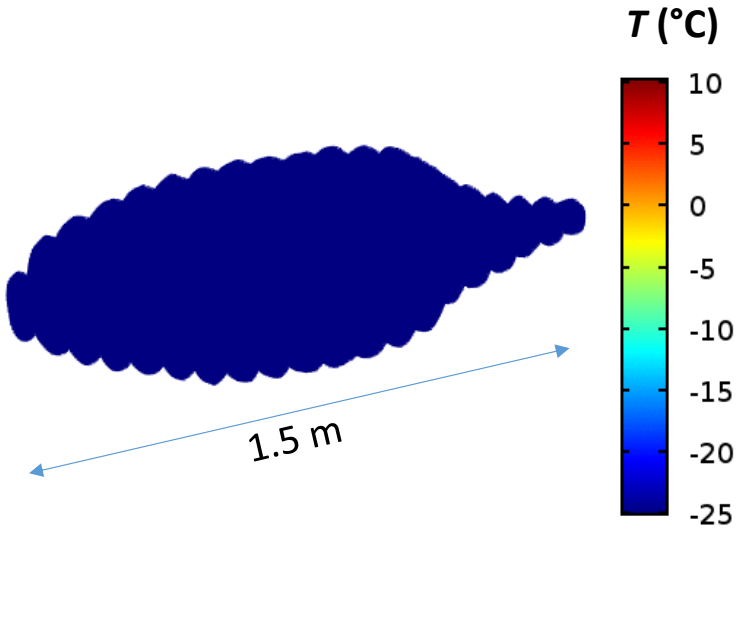


Temperature profile during thawing (h= 20 W/m²/K)



➔ Good agreement between predicted and measured temperatures





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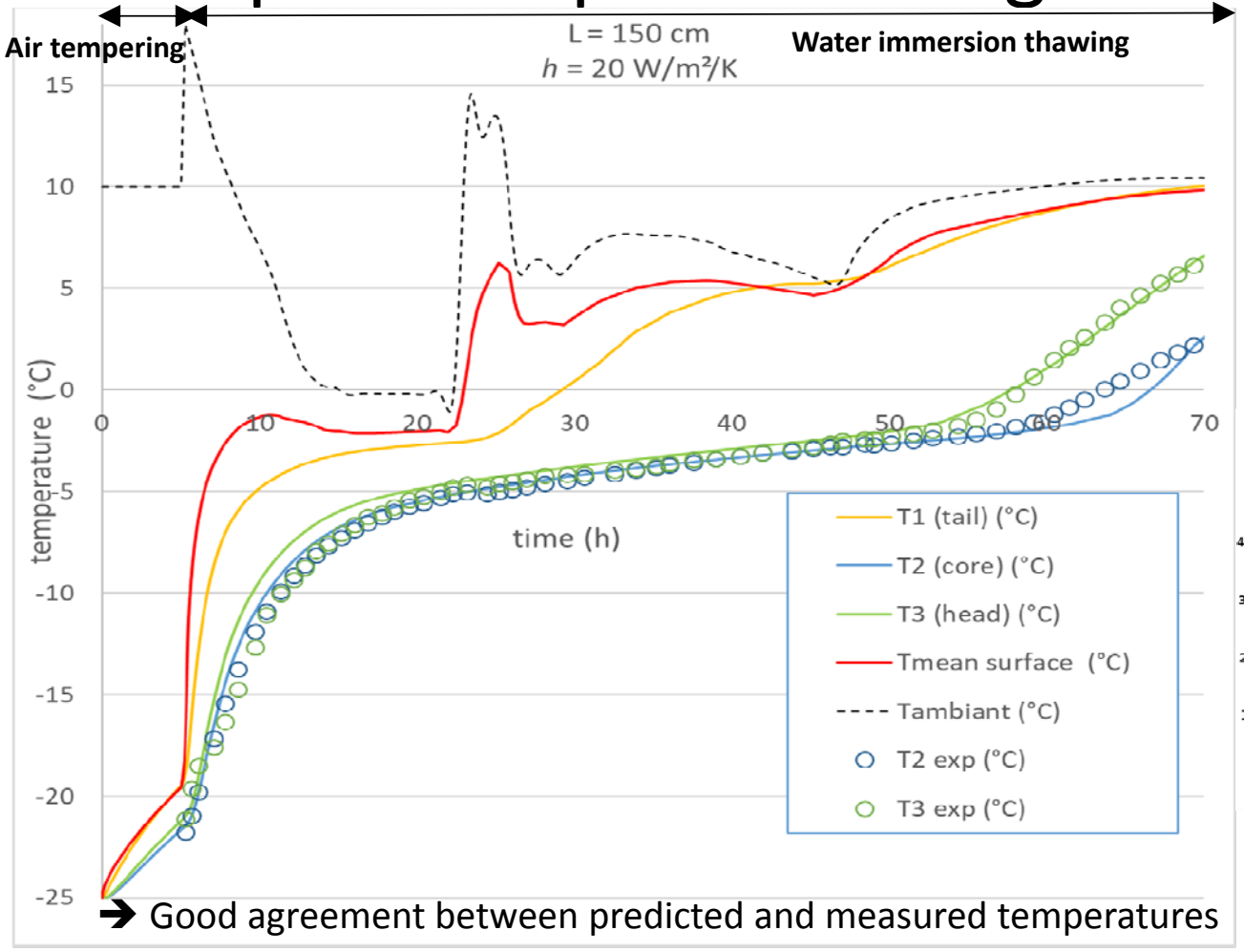
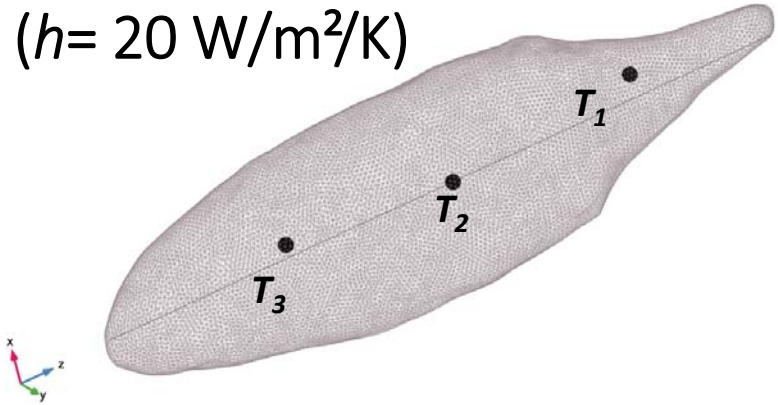
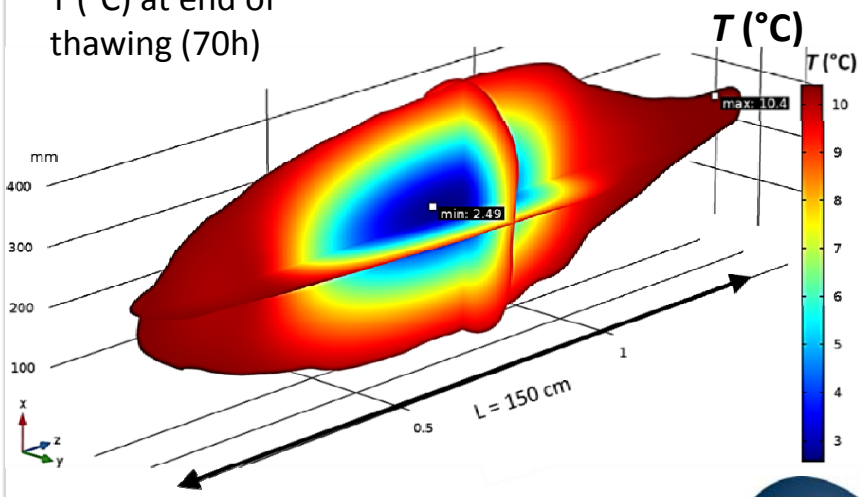


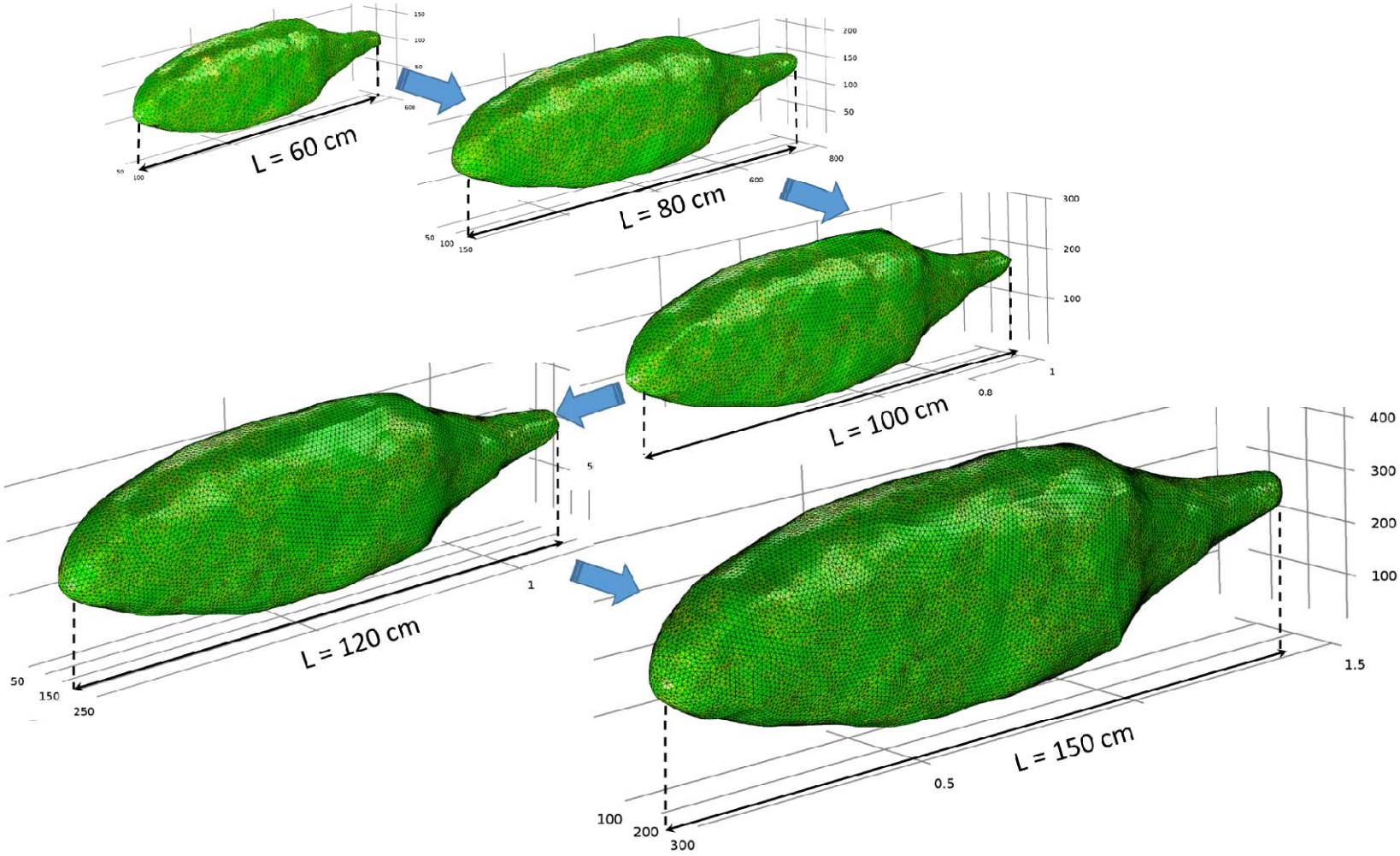


T (°C) at end of thawing (70h)

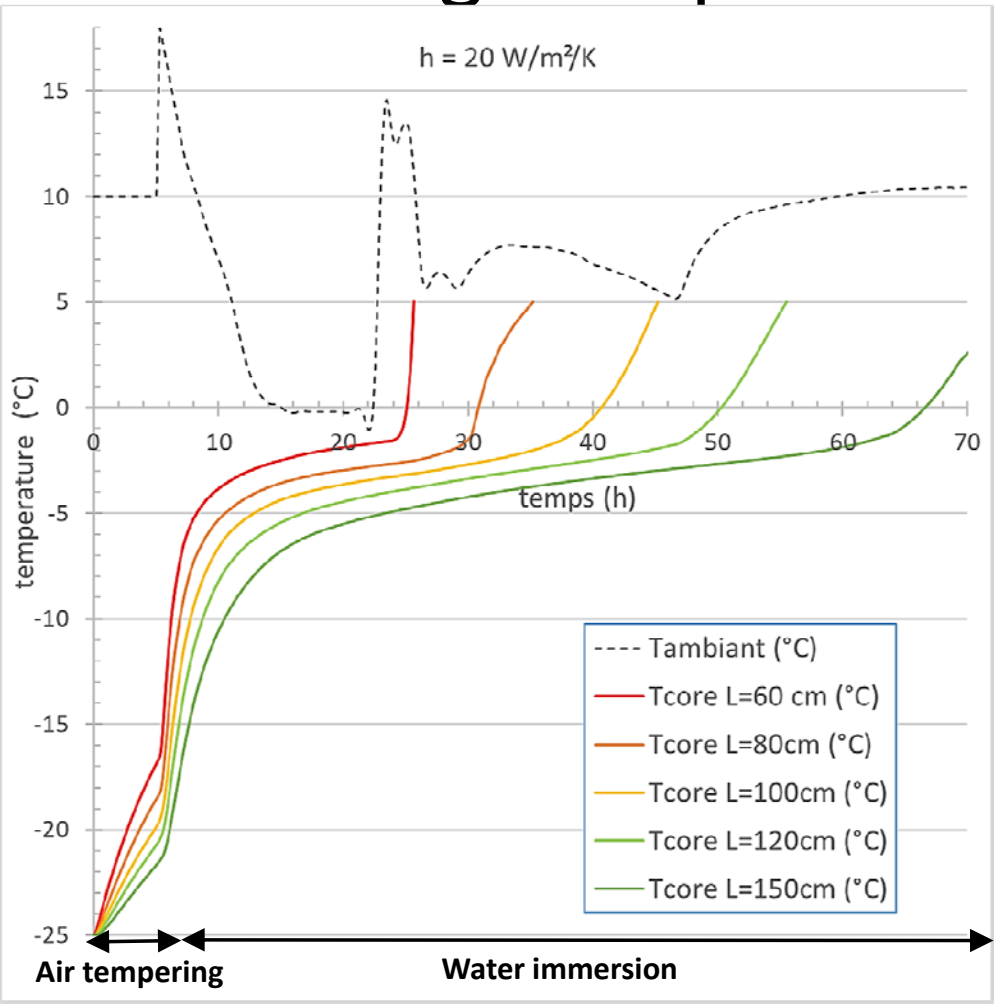


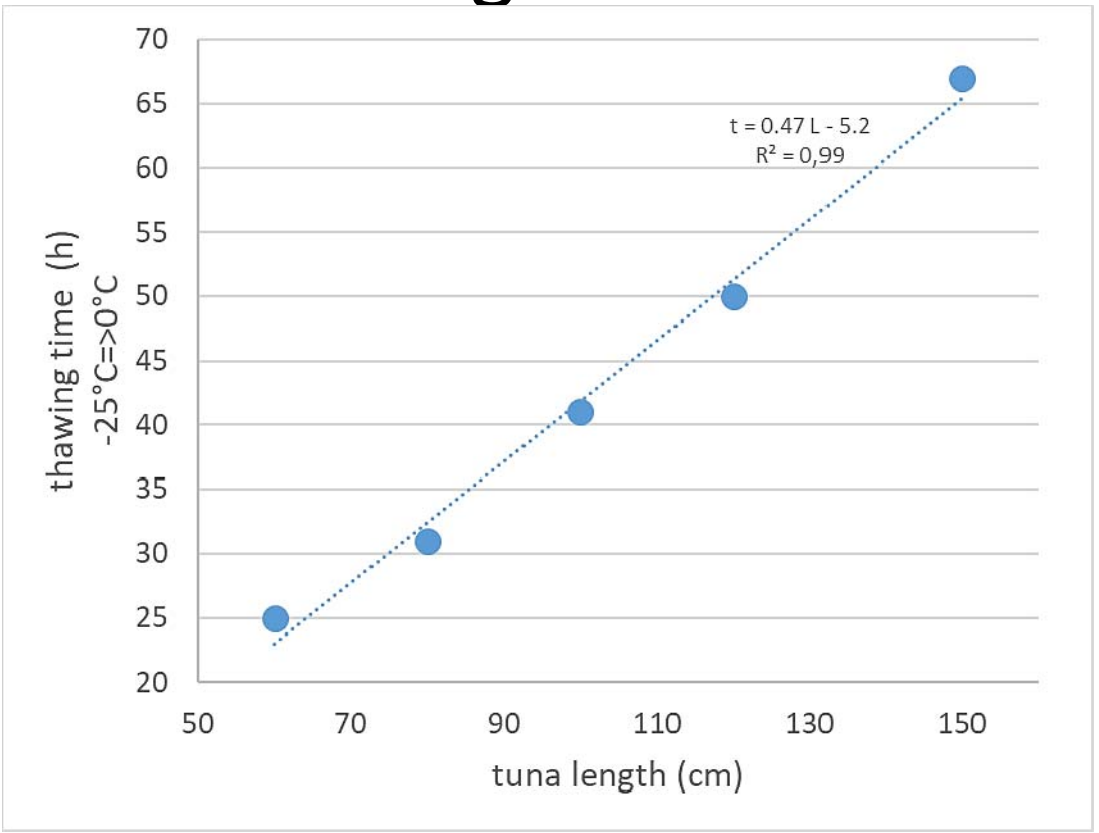
➔ Good agreement between predicted and measured temperatures

Generation of different-sized fishes



Thawing time prediction vs. tuna length





➔ Linear increase of thawing time vs. tuna length

Modelling thawing of real tuna fishes:

- Successful reconstruction of the real geometry from MRI scanning techniques
- Good prediction of inner temperatures of the fish during the process (tempering + thawing)
- Extrapolation of results for different sized-products
- Future directions of the work will include the influence of the external temperature evolution on the thawing time prediction.

Thank you for your attention

More information on poster n°102

on Tuesday evening at 16:30