



## Numerical Modeling of melt pool in the powder bed fusion processes

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## PTC MOBAFA

# Numerical Modeling of melt pool in the powder bed fusion processes

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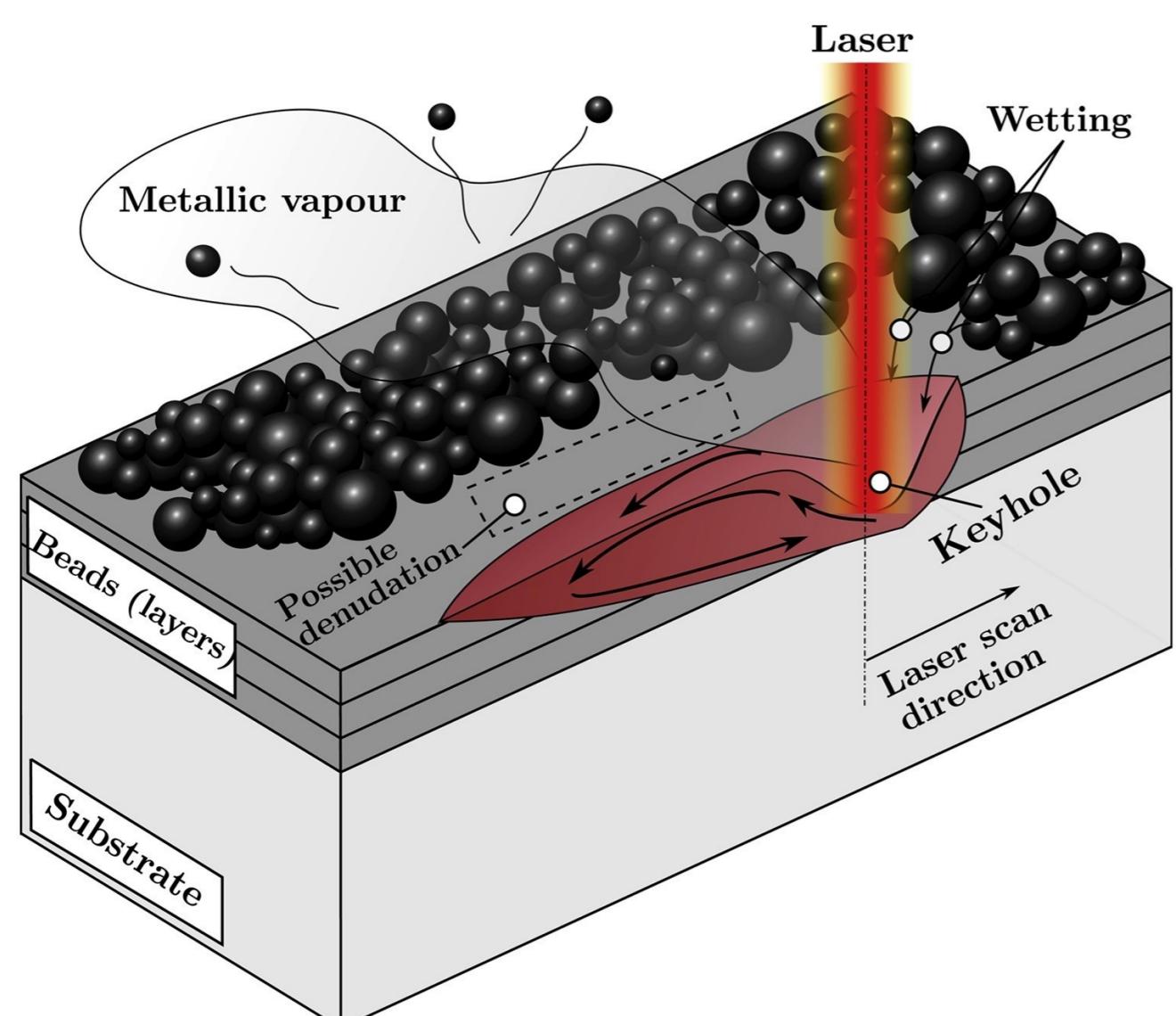
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Post-Doctoral : Dihya MEZI

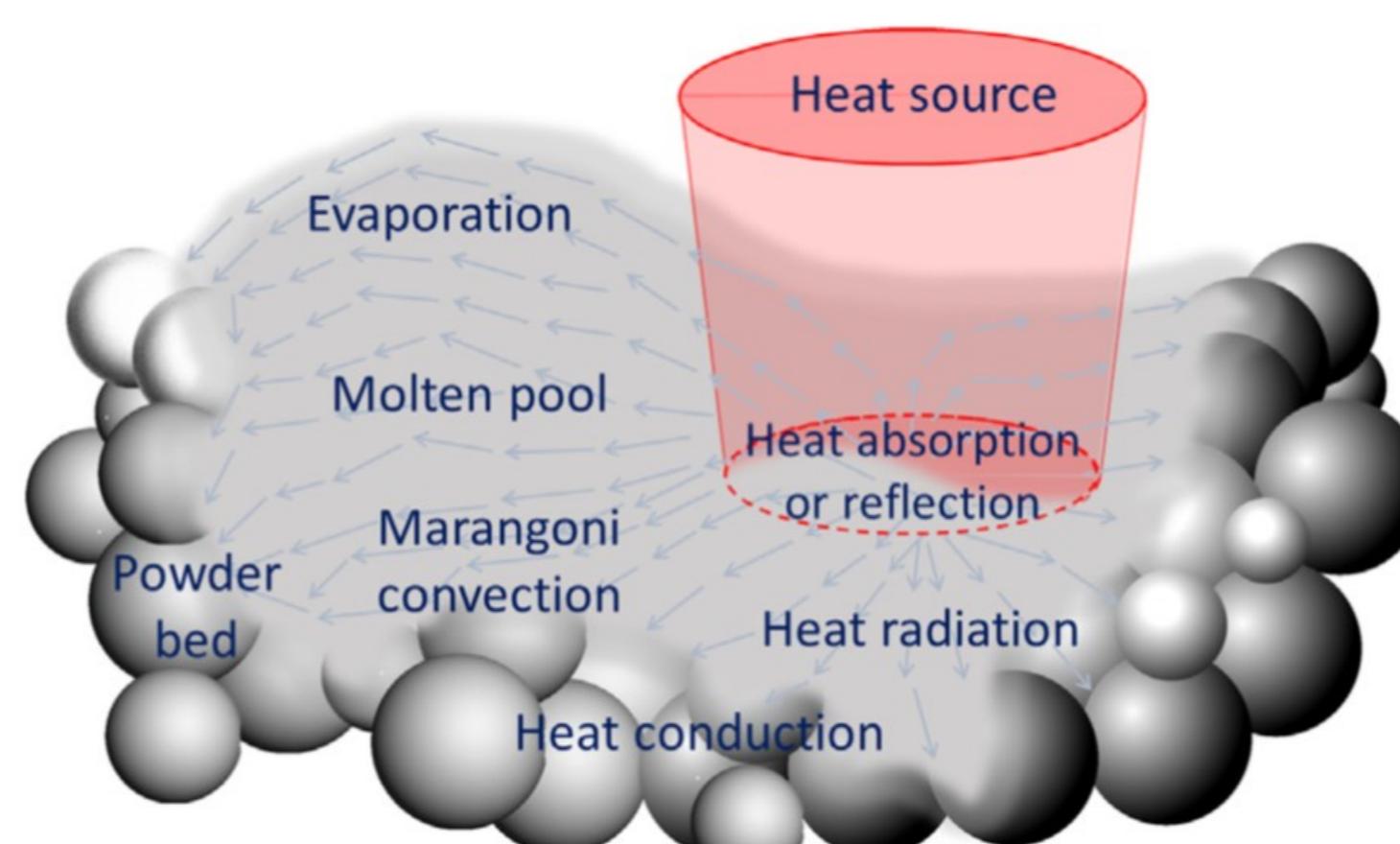
Date : 15/12/2021 to 14/12/2022

### Additive Manufacturing



Powder bed fusion processes [1]

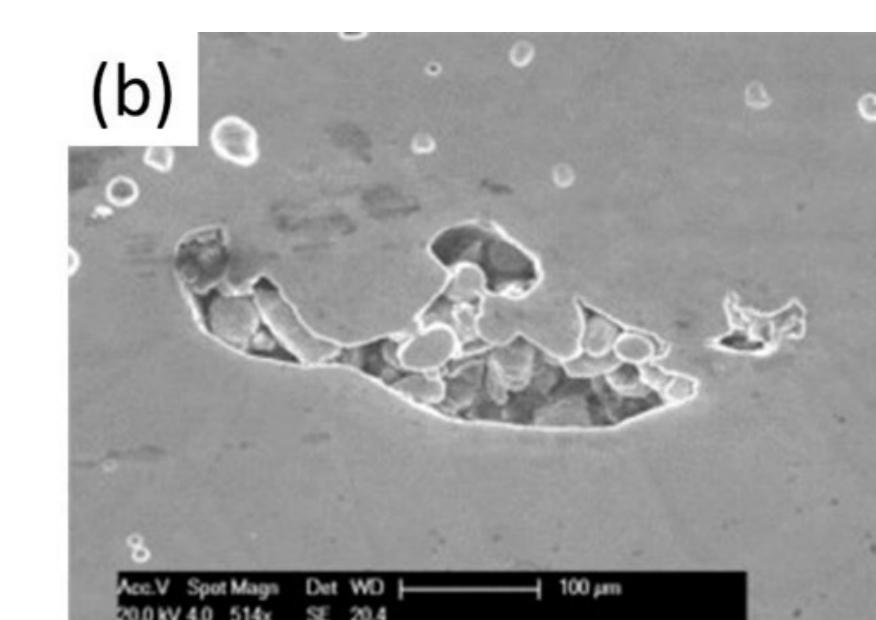
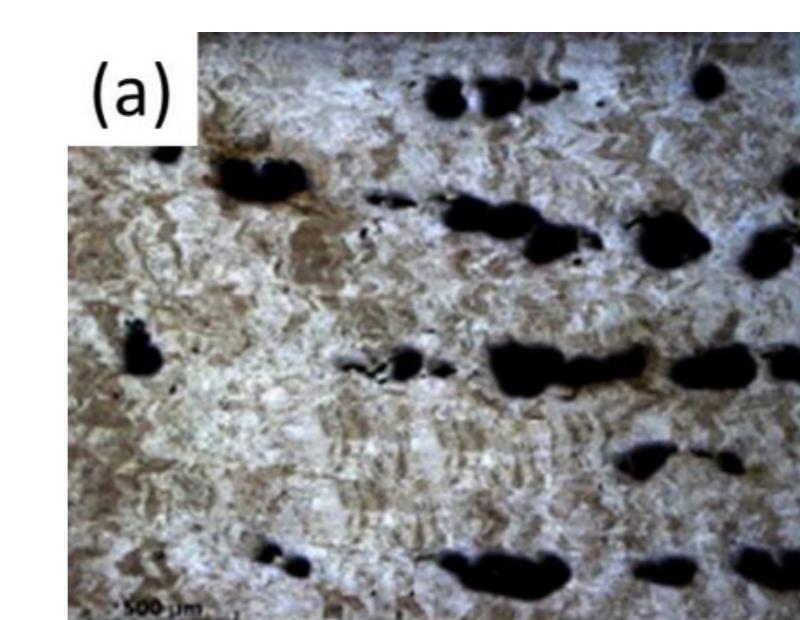
### Metal melt pool



Physical phenomenon [2]

Heat source  $\leftrightarrow$  Melt pool  $\leftrightarrow$  Part  
 Thermocapillary flow

### Objectives

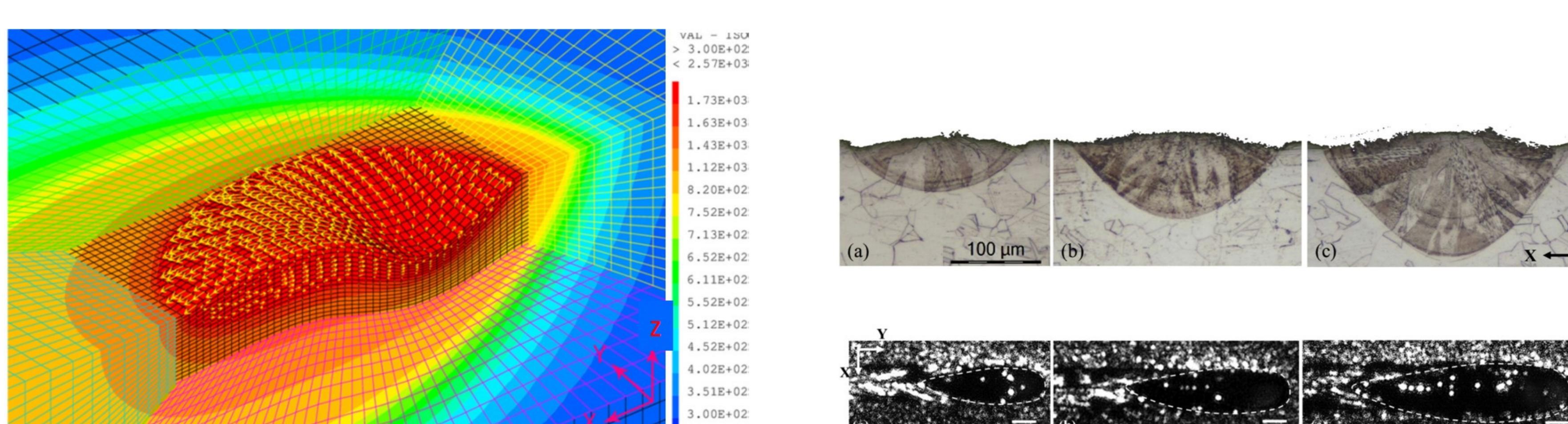


Porosity formation [2]

- Describe the physical phenomena in the melt pool
- Scientific understanding of melt morphology
- Process optimization : quality, speed ...

### Context

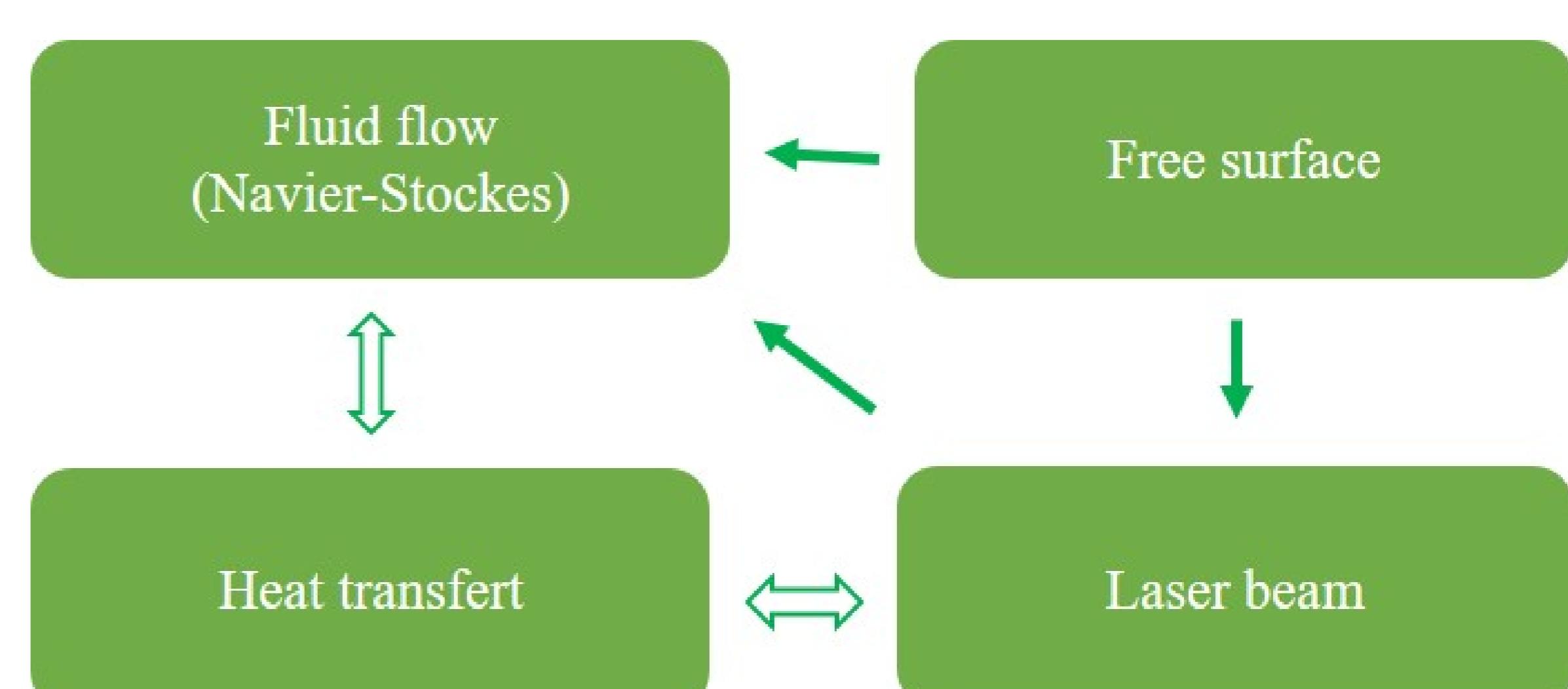
- Numerical modeling of the melt pool for additive manufacturing using Cast3m [3]
- Input parameters : power/speed (320 W / 250 mm/s), laser diameter (0.15 mm) ...
- Output parameters : melt pool size (macrographic section)



Numerical model of the melt pool [4]

Experimental tests [5]

### Multiphysics Model



- Assumptions ;
  - Stationary study,
  - Newtonian fluid, incompressible and laminar flow.

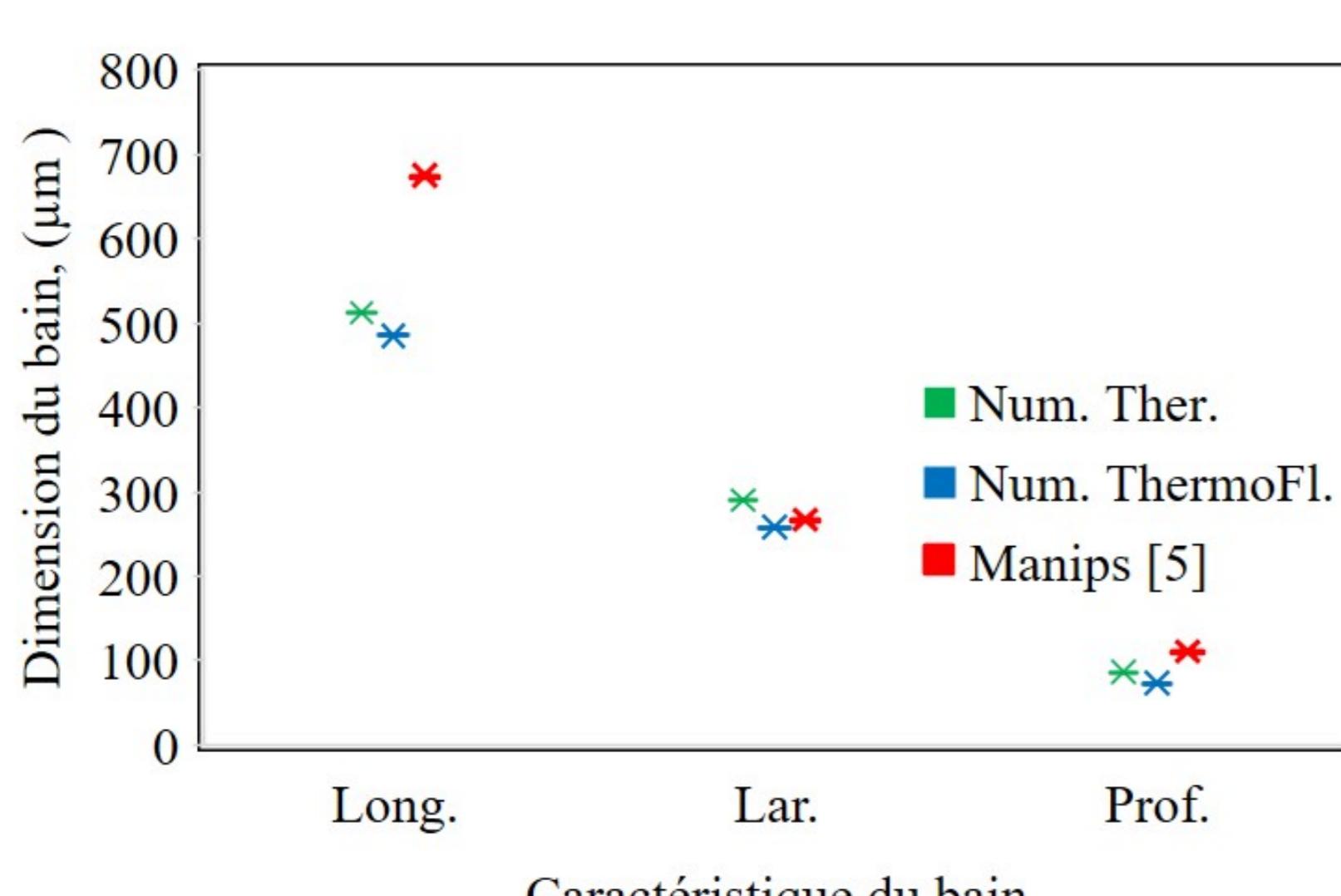
$$\vec{\nabla} \cdot \vec{u} = 0$$

$$\rho(\nabla \vec{u}) \cdot \vec{u} = -\vec{\nabla} p + \vec{\nabla} \cdot \mu(\vec{\nabla} \vec{u} + \vec{\nabla} \vec{u}^T) + \vec{f}_{Bous} + \vec{f}_{Lor} + \vec{f}_{Ext}$$

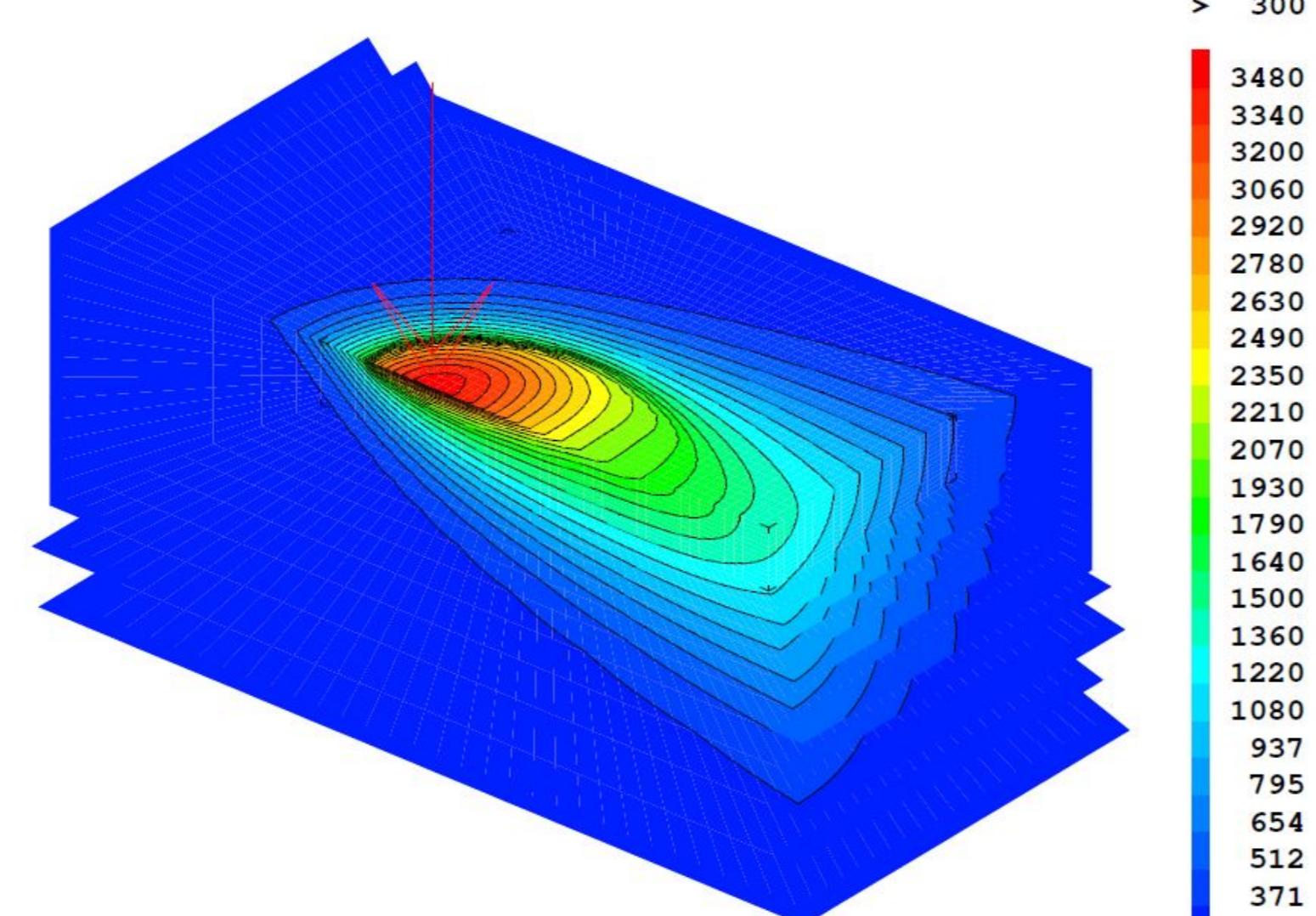
$$\rho \vec{u} \cdot (\vec{\nabla} h) - \vec{\nabla} \cdot \lambda \vec{\nabla} T = \vec{s}$$

### Conclusions

- Numerical modeling of the melt pool without using the free surface.
- The depth and width results converge to the experimental ones [5].
- Take account into the evaporation and recoil pressure phenomena.
- Simulation of the melt pool with the free surface.



Melt pool size



Temperature in the melt pool

### References

- [1] A. Queva, "Simulation numérique multiphysique du procédé de fusion laser de lit de poudre : Application aux alliages métalliques d'intérêt aéronautique," 2021.
- [2] T. DebRoy et al., "Additive manufacturing of metallic components – Process, structure and properties," vol. 92, pp. 112–224.
- [3] Cast3m, "Cast3m web site, <http://www-cast3m.cea.fr/>"
- [4] M. C. Nguyen, "Modélisation et simulation multiphysique du bain de fusion en soudage à l'arc TIG," 2015.
- [5] A. Baumard, "Prédiction des structures de grain d'un composant en acier 316L élaboré par fabrication additive fusion laser sur lit de poudre," 2020.