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Dihya Mezi, Stephane Gounand, Jean-Paul Garandet, Guilhem Roux, Hicham Maskrot. Numerical Modeling of melt pool in the powder bed fusion processes. Ametis - Advanced Manufacturing for Energy and Transportation International School 2022, Jun 2022, Taglio, Corse, France. . <hal-04108216>

HAL Id: hal-04108216

<https://hal.science/hal-04108216v1>

Submitted on 30 May 2023

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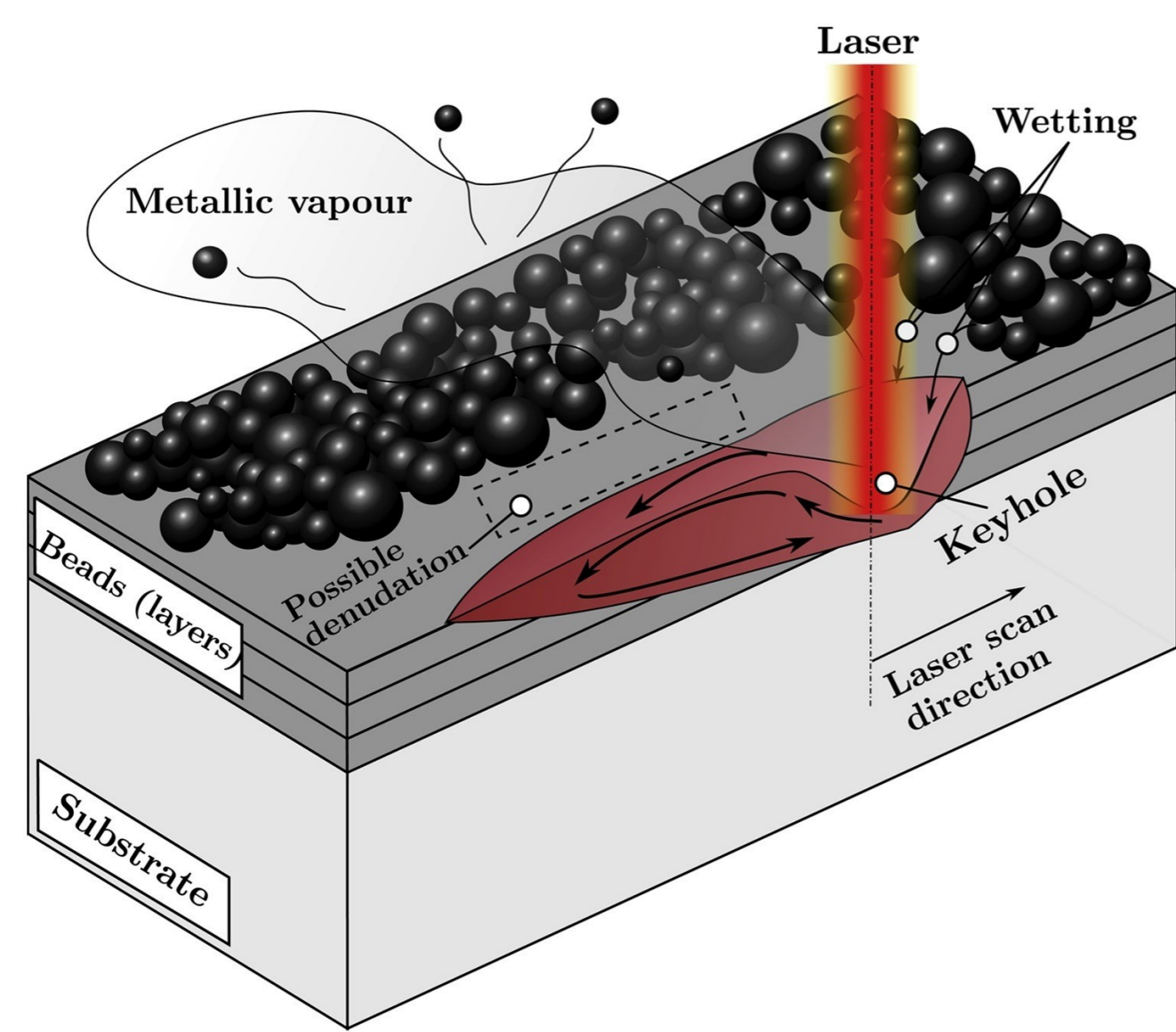
PTC MOBAFA

Numerical Modeling of melt pool in the powder bed fusion processes

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 Guilhem ROUX (DRT/LITEN/STNM/SA3D/L3M)
 Hicham MASKROT (DES/ISAS/DPC/SEARS/LISL)

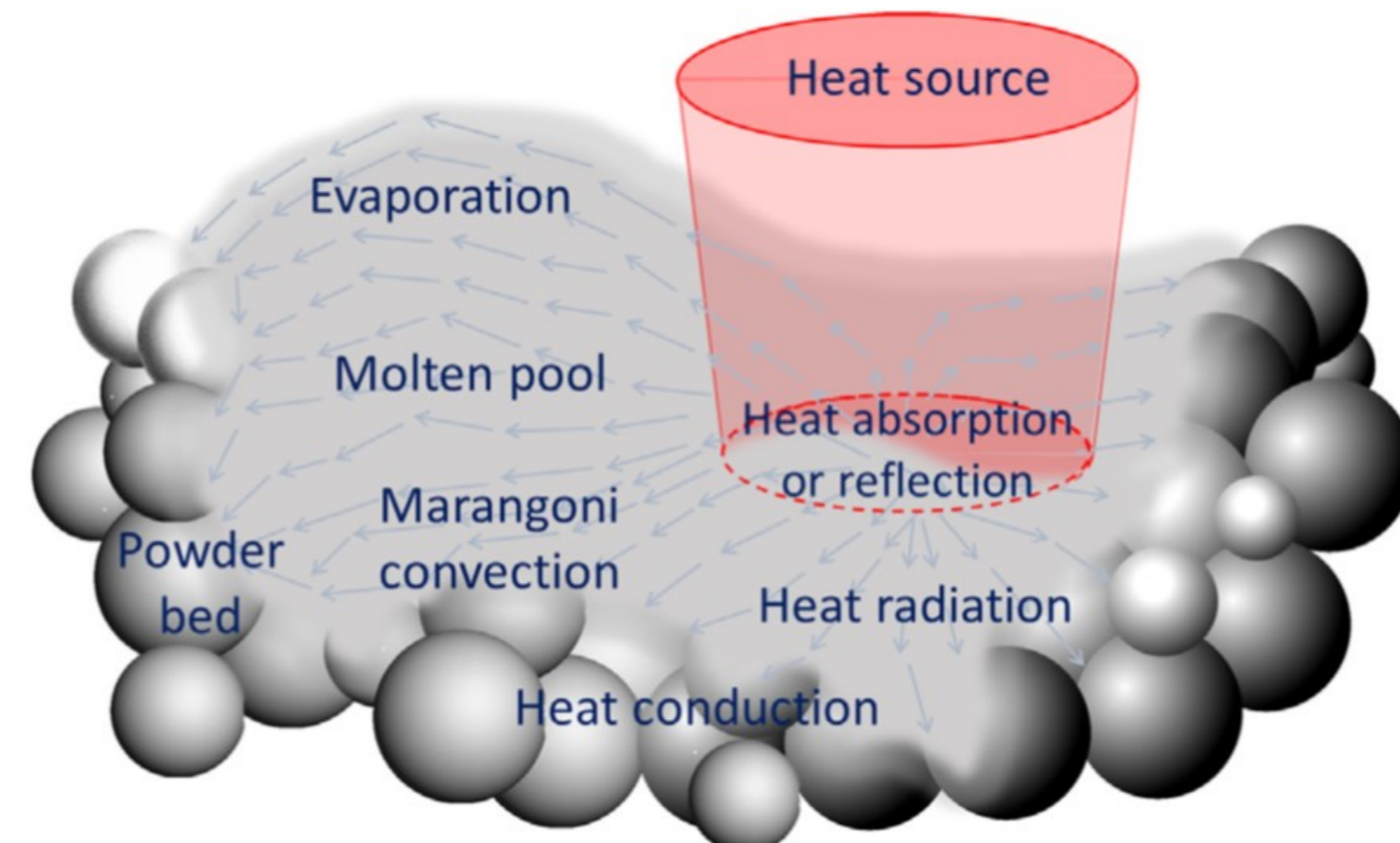
Post-Doctoral : Dihya MEZI
 Date : 15/12/2021 to 14/12/2022

Additive Manufacturing



Powder bed fusion processes [1]

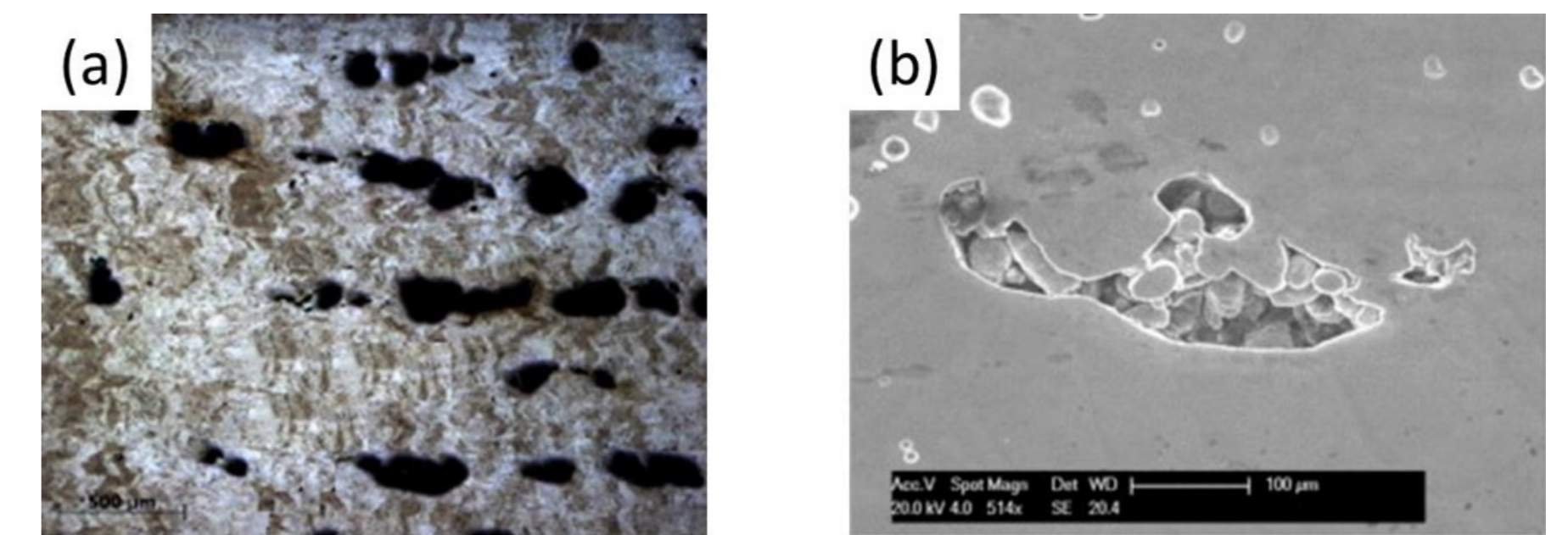
Metal melt pool



Physical phenomenon [2]

Heat source \Leftrightarrow Melt pool \Leftrightarrow Part
 Thermocapillary flow

Objectives

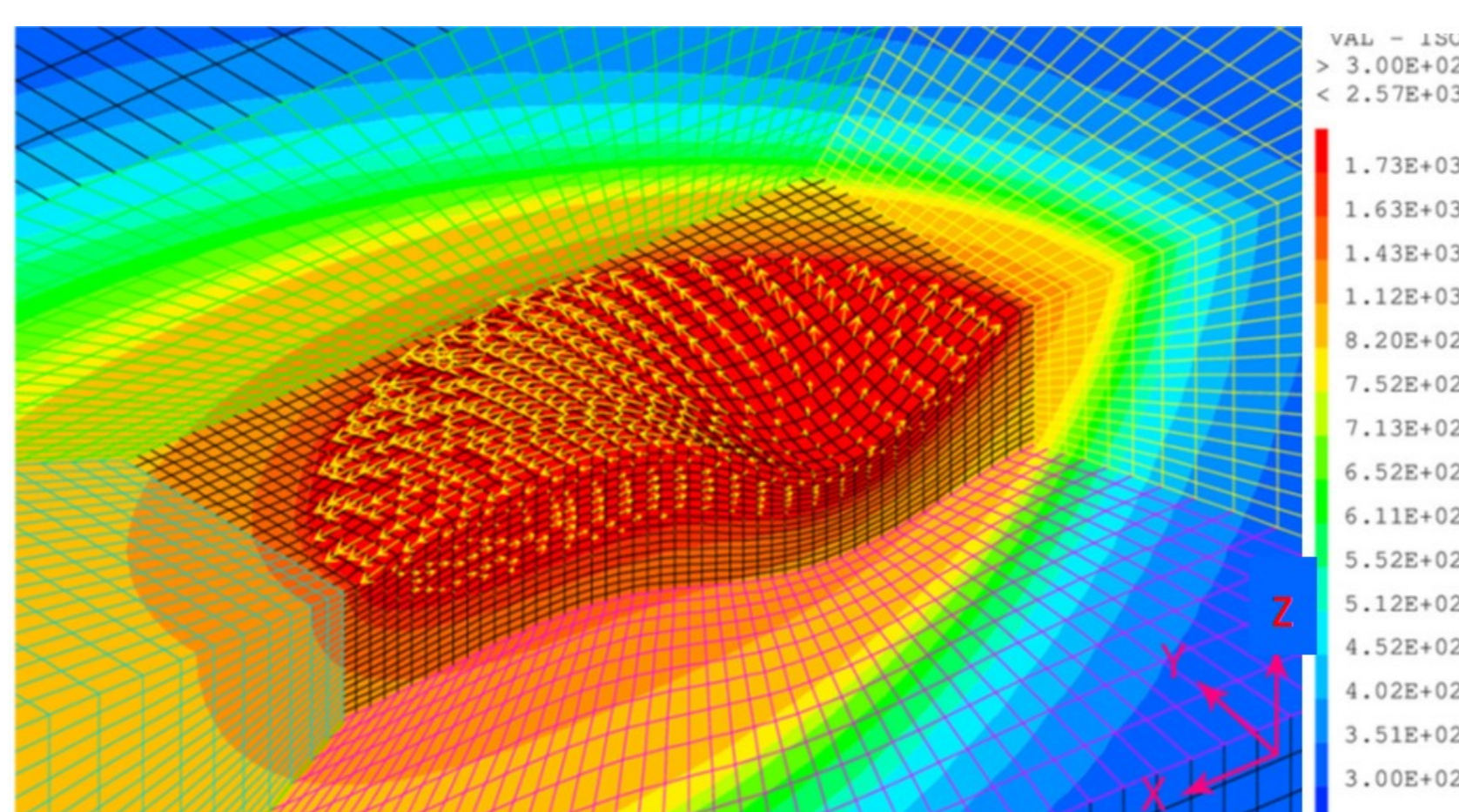


Porosity formation [2]

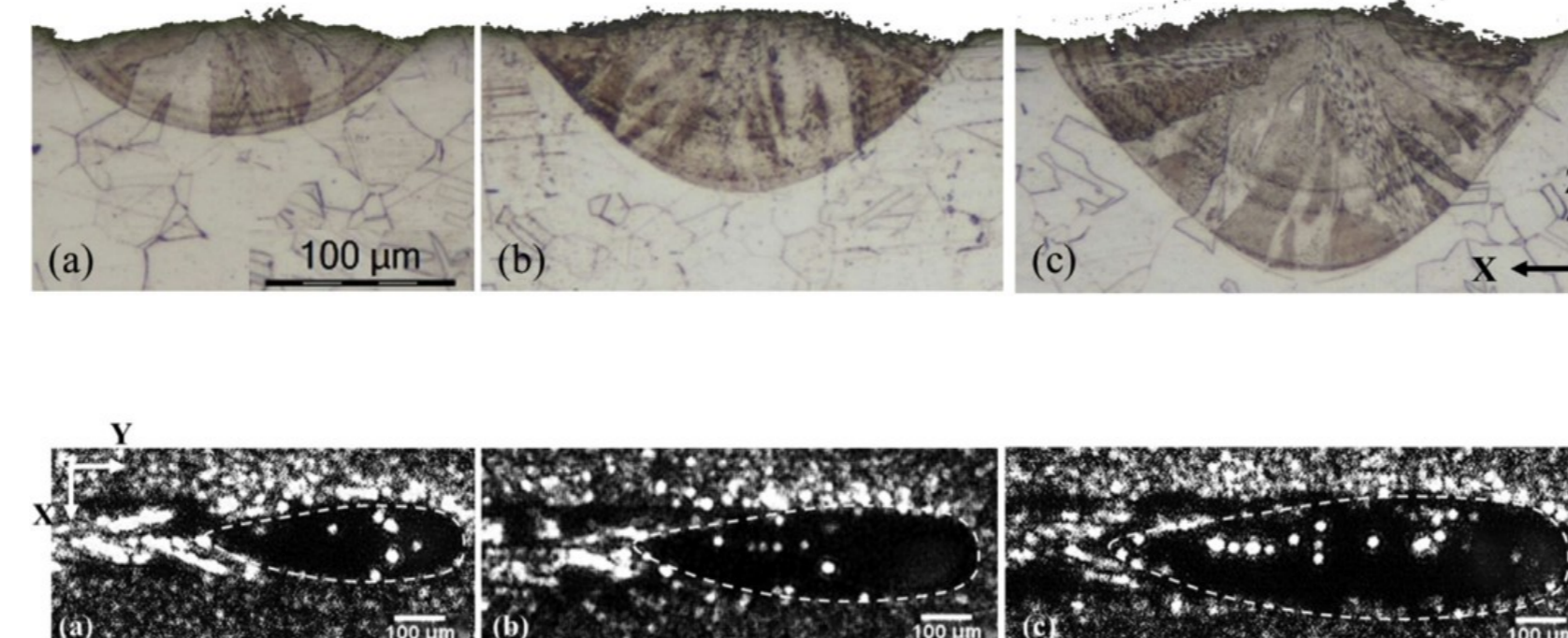
- Describe the physical phenomena in the melt pool
- Scientific understanding of melt morphology
- Process optimization : quality, speed ...

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)

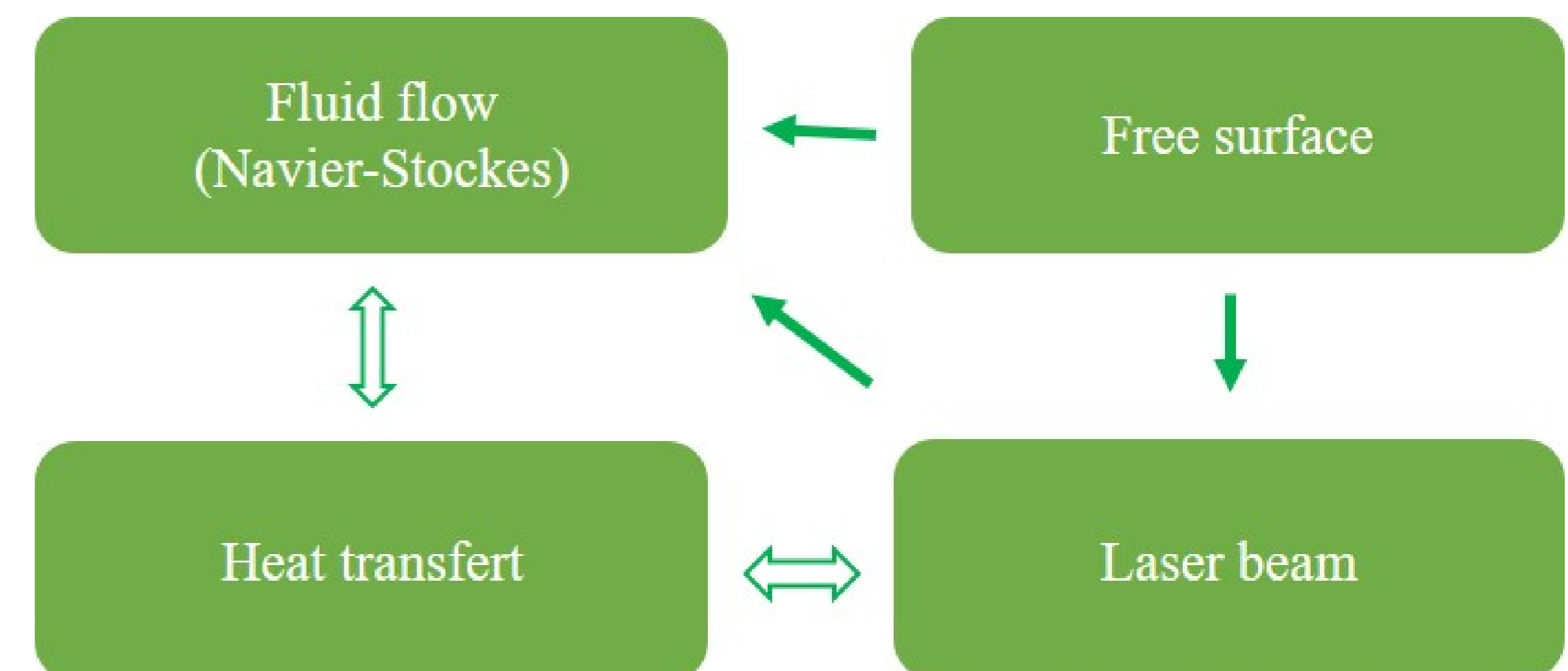


Numerical model of the melt pool [4]



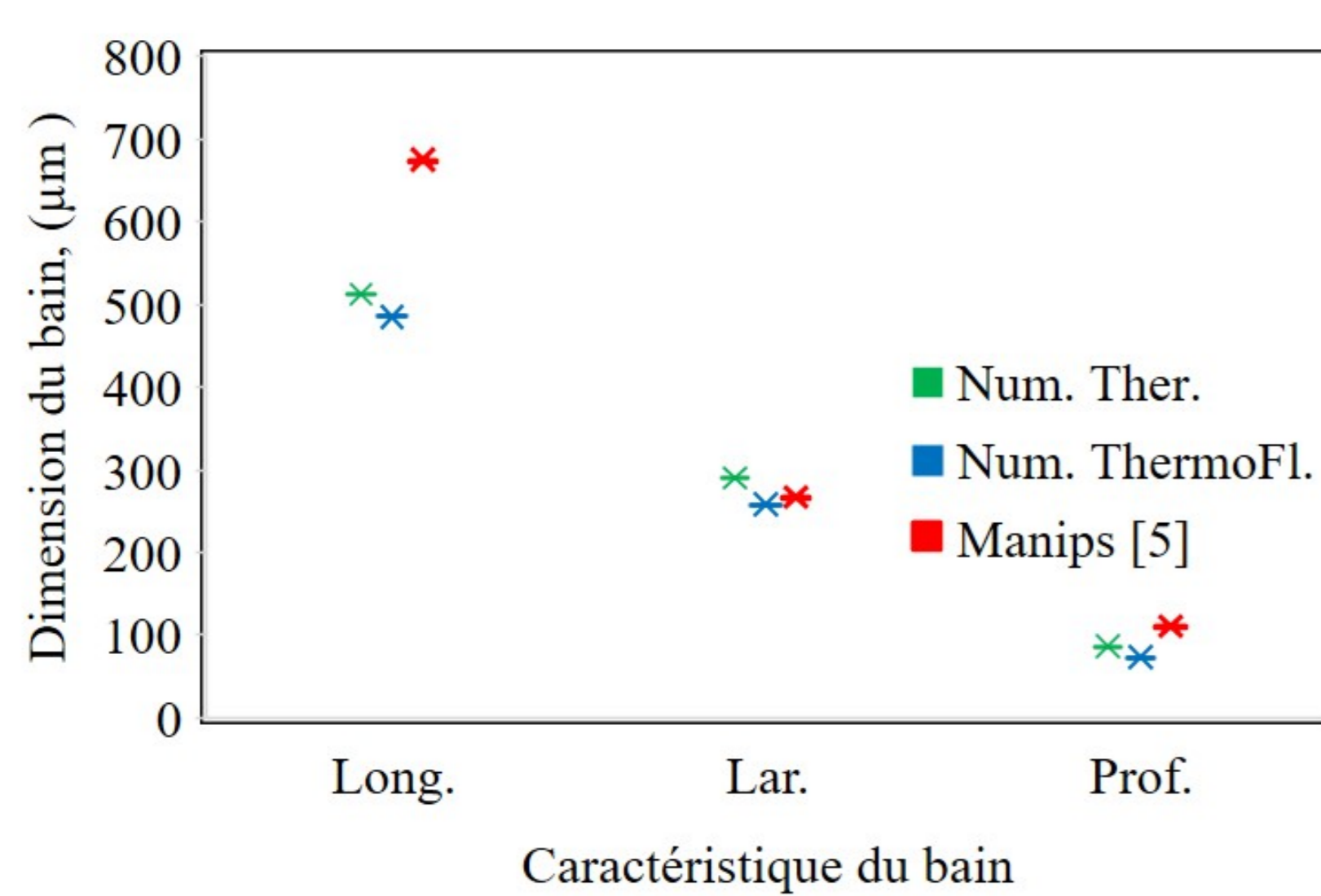
Experimental tests [5]

Multiphysics Model

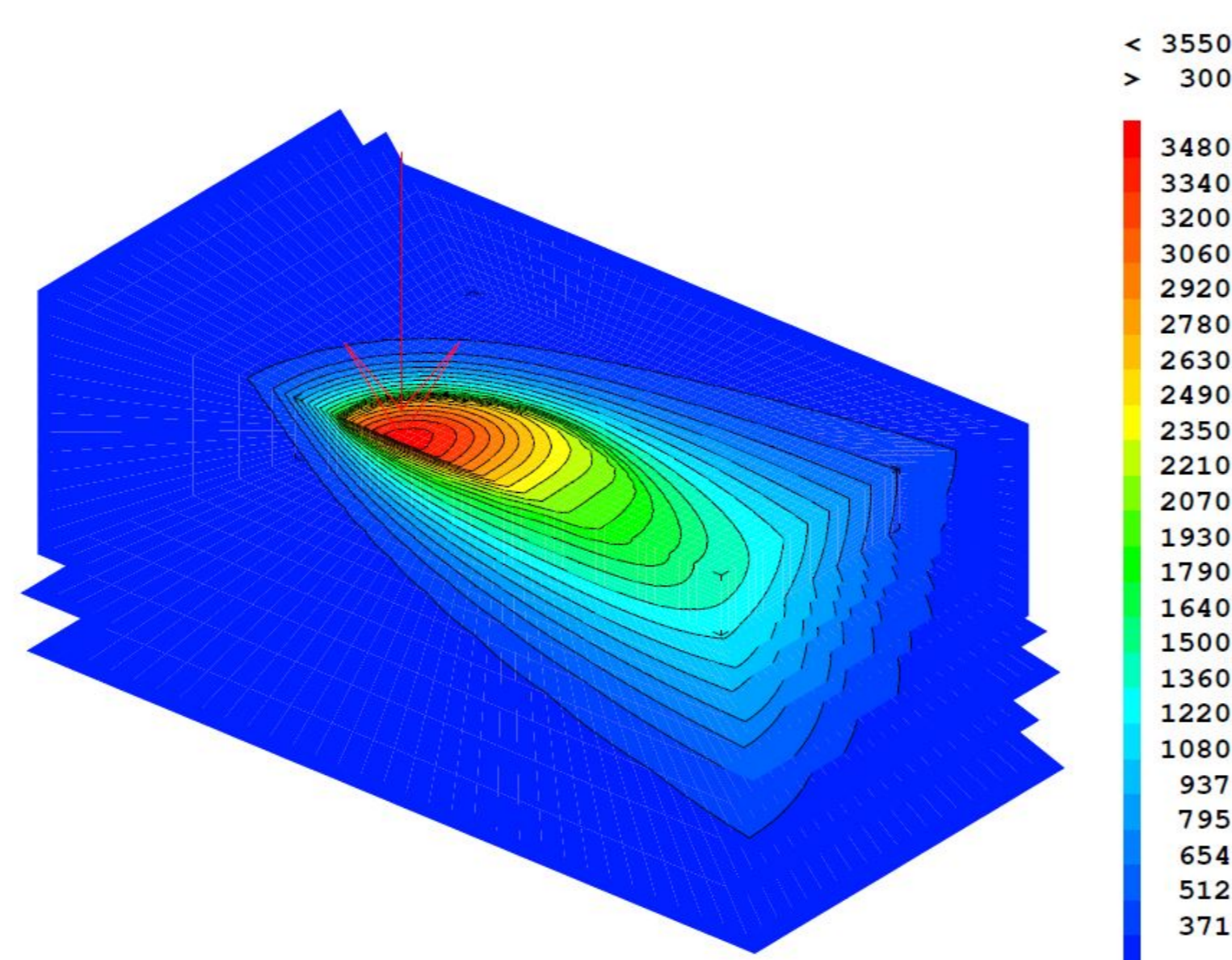


- Assumptions ;
- Stationary study,
- Newtonian fluid, incompressible and laminar flow.

Results



Melt pool size



Temperature in the melt pool

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

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

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

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.

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.