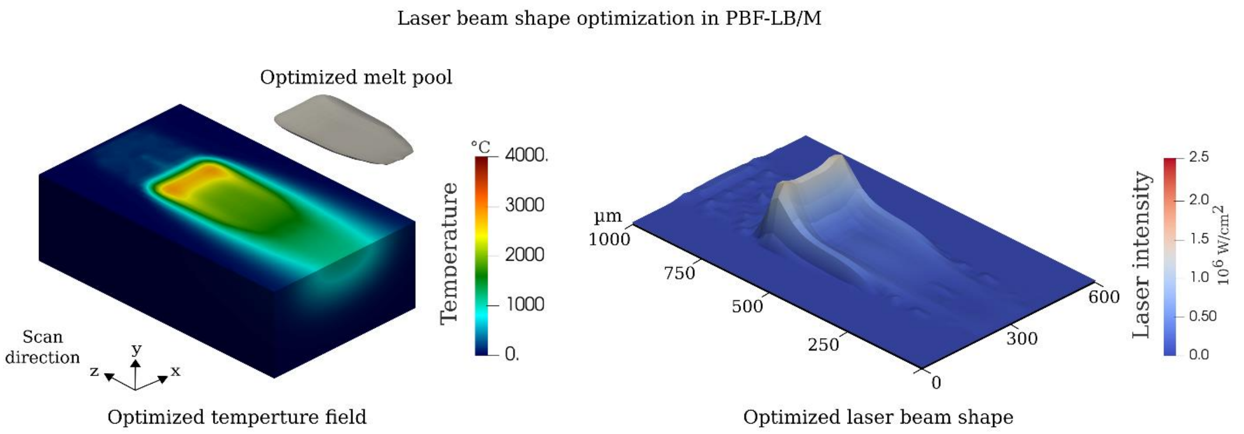
Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
Technical University of Munich

Modeling:
Mathematics:
Programming:
Science:

# Software Lab:

## Optimal Control of Thermal Gradients in Laser-Based Additive Manufacturing Processes

### Description




Optimal control of tempreature distribution/meltpool in PBF-LB/M [1]

Laser-based additive manufacturing processes, such as Powder Bed Fusion of metals using lasers (PBF-LB/M), involve creating final shapes by melting and fusing metal powder in layers with a laser. The highly localized heat source from the laser generates thermal stresses that can lead to warping, cracking, and other issues in the printed product. The spatial intensity distribution of the laser significantly influences the thermal field, its gradient, and the resulting thermal stresses during the process. This project aims to control the thermal gradient and cooling rate by optimizing the shape of the laser beam. This will be achieved through an inverse problem approach using adjoint-based optimization. To accomplish this, the existing linear heat model in the 2D finite element method will be extended to a non-linear model to accurately predict temperature evolution and its gradient from given laser beam shape, known as the forward problem. Then, the corresponding adjoint-state equation will be developed to solve the inverse problem of determining the optimal laser beam shape for a specific stress field.

### Task

Tasks for the project involve (python)

1) Extend the existing model  to non-linear heqat quation model
2) Derive the corresponding adjoint-state equation
3) Set-up the inverse/adjoint solver
4) Optimize the laser intensity distribution for different given thermal gradients/cooling rates

### Supervisor

Vijaya Holla, Chair of Computational Modeling and Simulation , vijaya.holla@tum.de

## References

[1] Holla, Vijaya, Philipp Kopp, Jonas Grünewald, Katrin Wudy, and Stefan Kollmannsberger. "Laser Beam Shape Optimization in Powder Bed Fusion of Metals." *Available at SSRN 4265496* (2022).