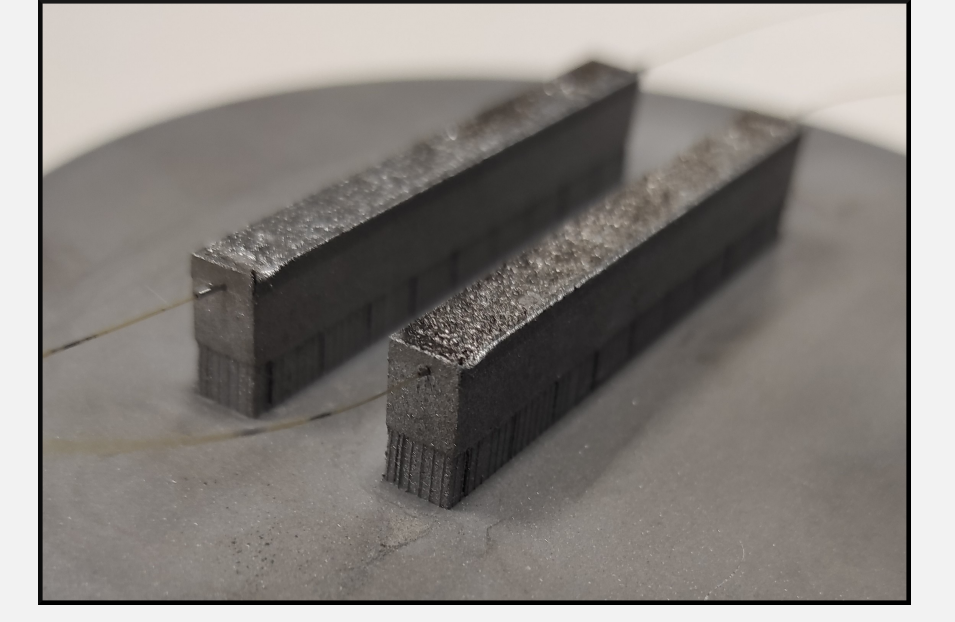


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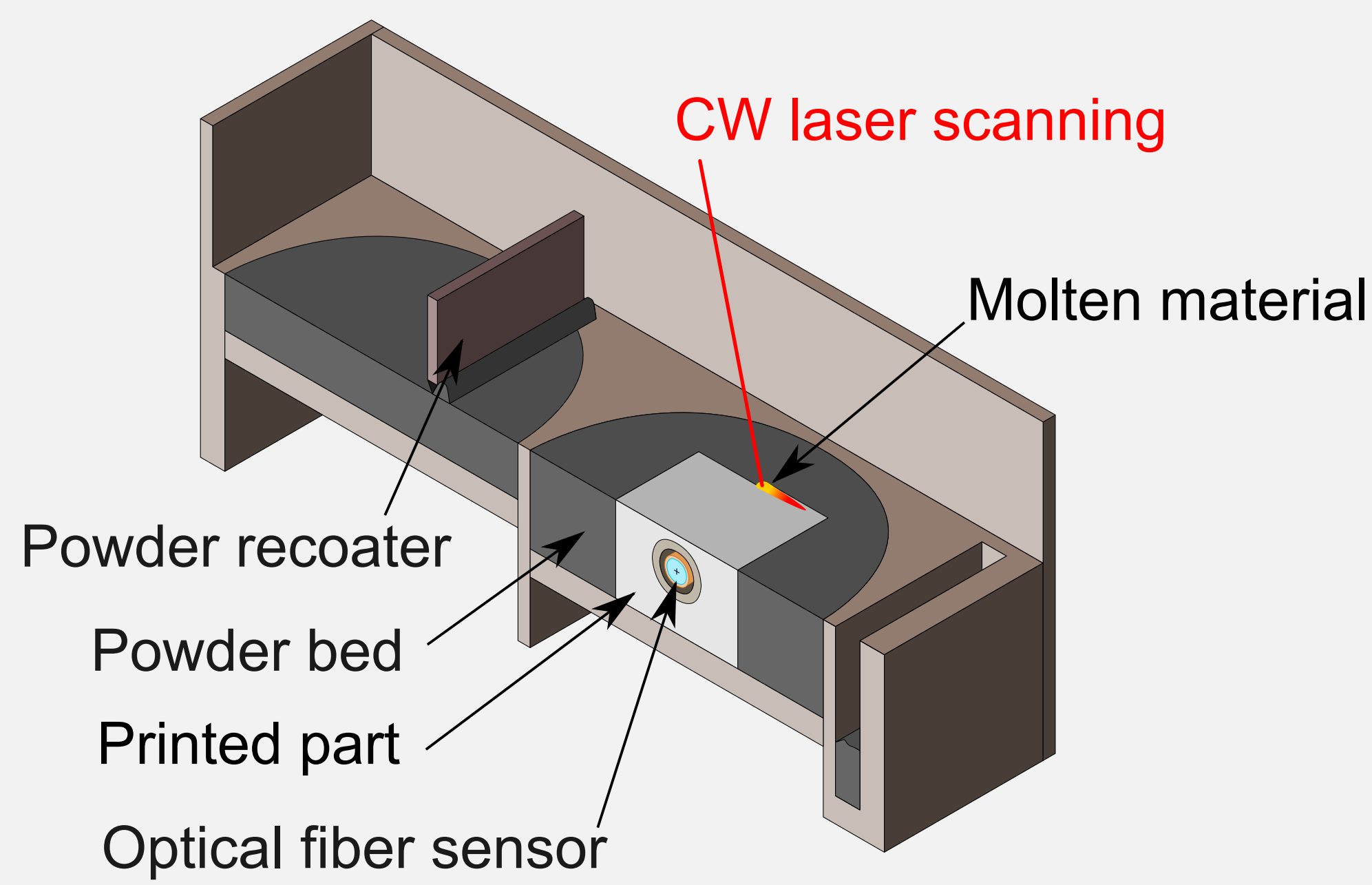
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1. Introduction

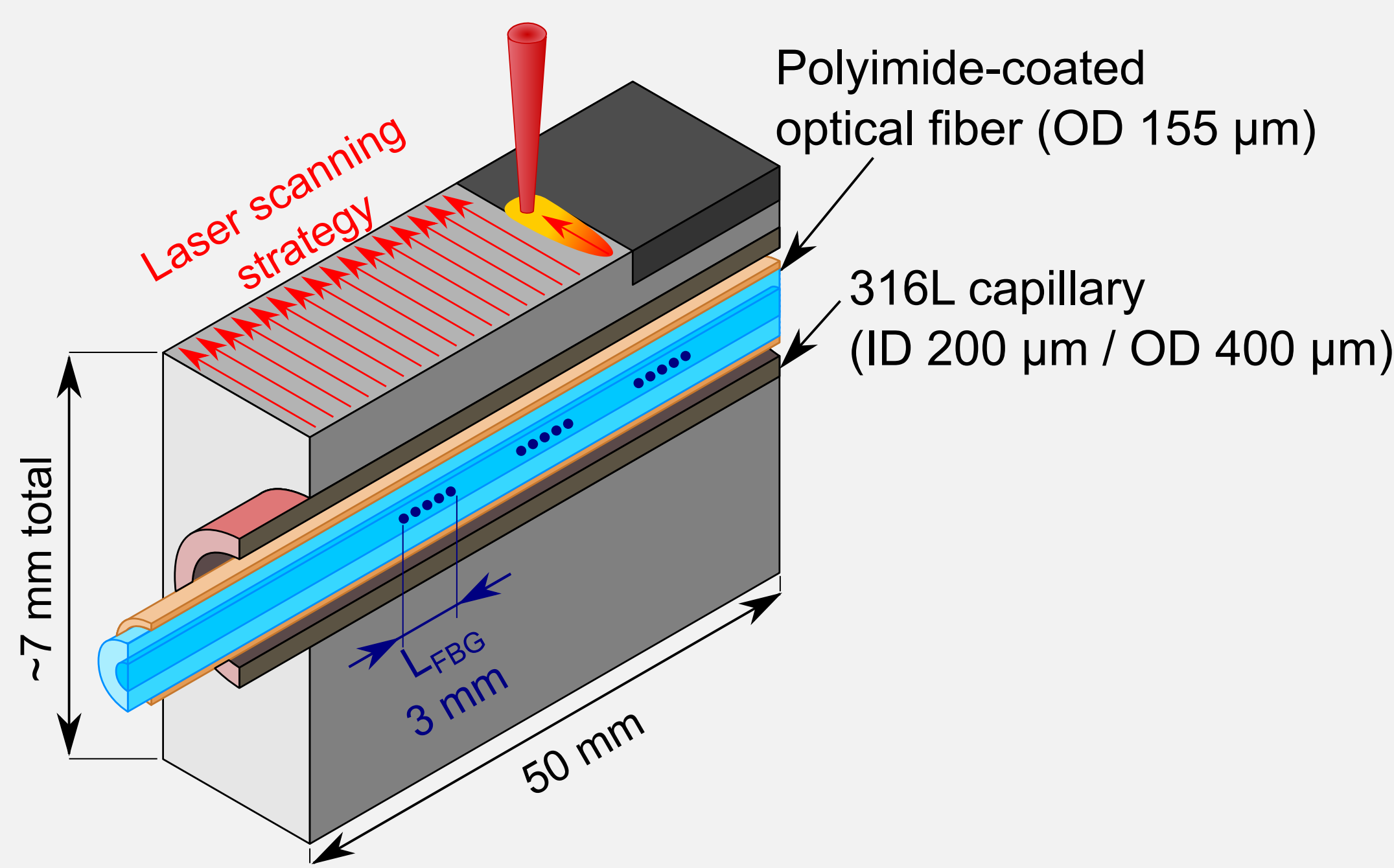
- We monitored the manufacturing of a 316L stainless steel part produced by Laser Powder-Bed Fusion (L-PBF)
- Optical fiber sensors (Fiber Bragg Gratings, FBGs) are used to determine the temperature in the part during the process
- The three FBGs are positioned in a capillary so they are strain-free → temperature measurement only
- The setup is modeled using simplifying hypotheses, and temperature values are extracted at the FBG positions



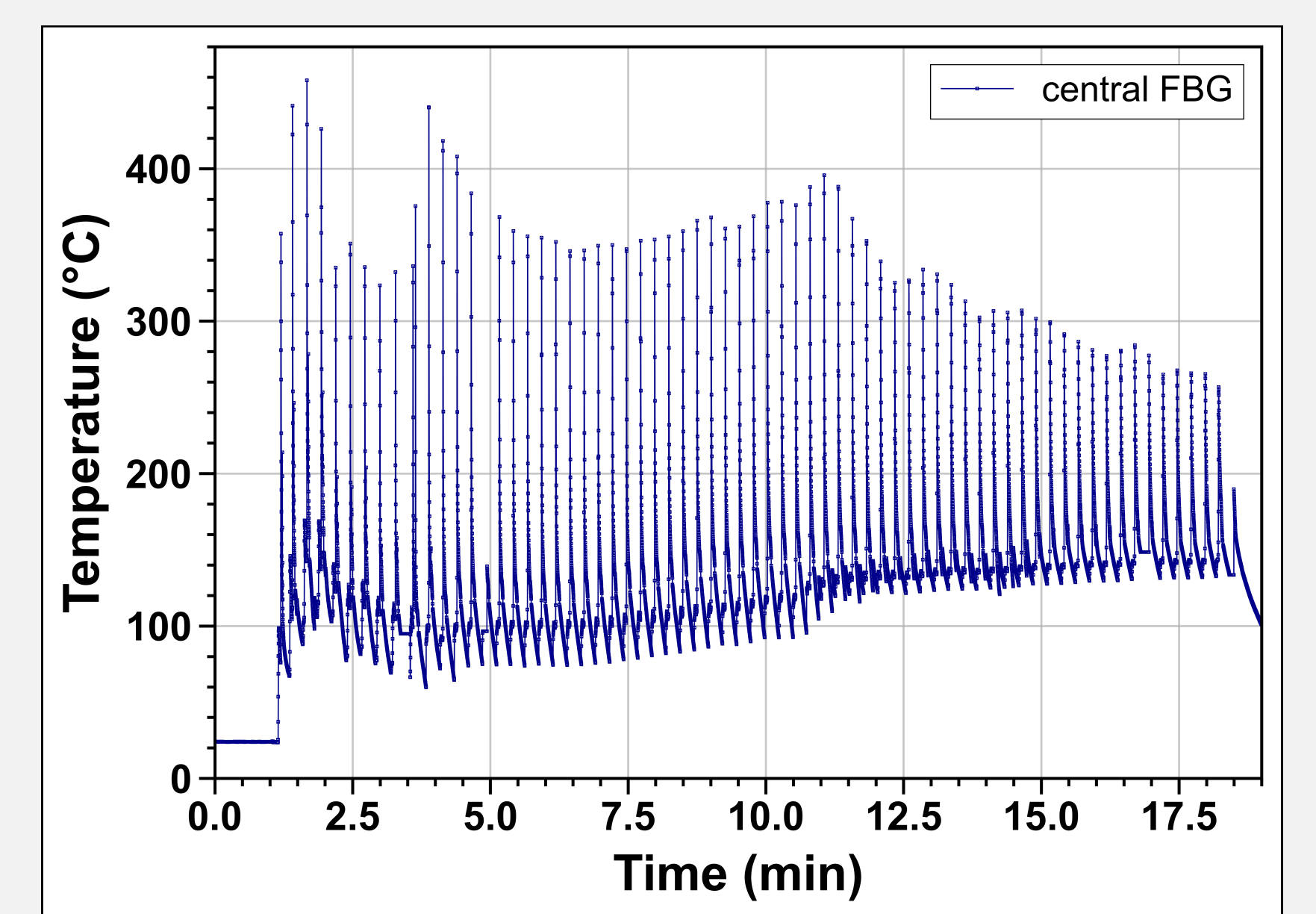
2. L-PBF process *in situ* monitoring



L-PBF process overview



Process temperature monitoring using FBGs



Temperature measurements with a FBG

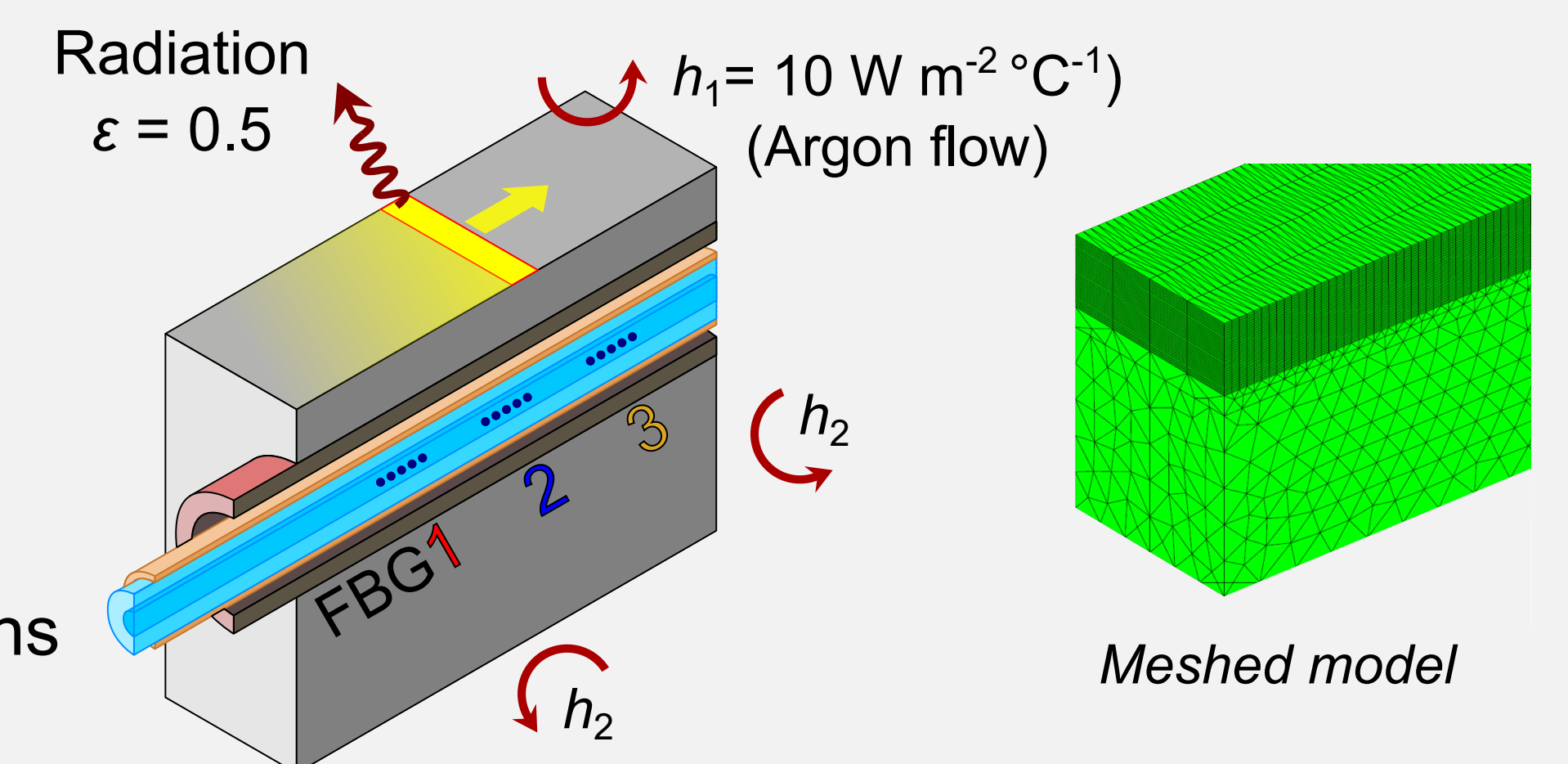
3. Modeling

Process parameters

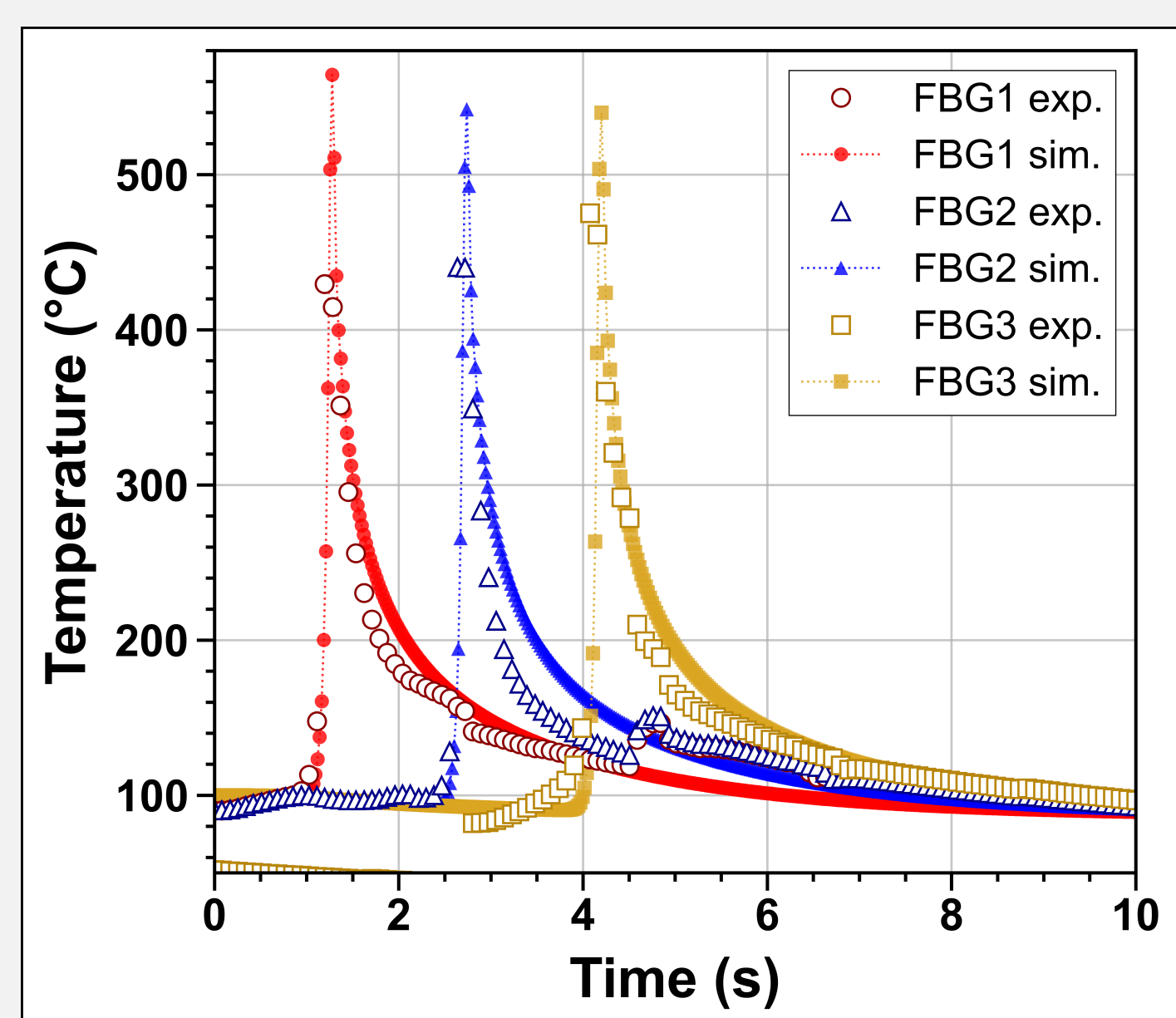
- $P_{\text{laser}} = 80 \text{ W}$ (gaussian spot $\varnothing 30\mu\text{m}$ at $1/e^2$)
- Powder layer height = $30 \mu\text{m}$
- 68 layers deposited
- $v_{\text{laser}} = 600 \text{ mm/s}$

Model parameters

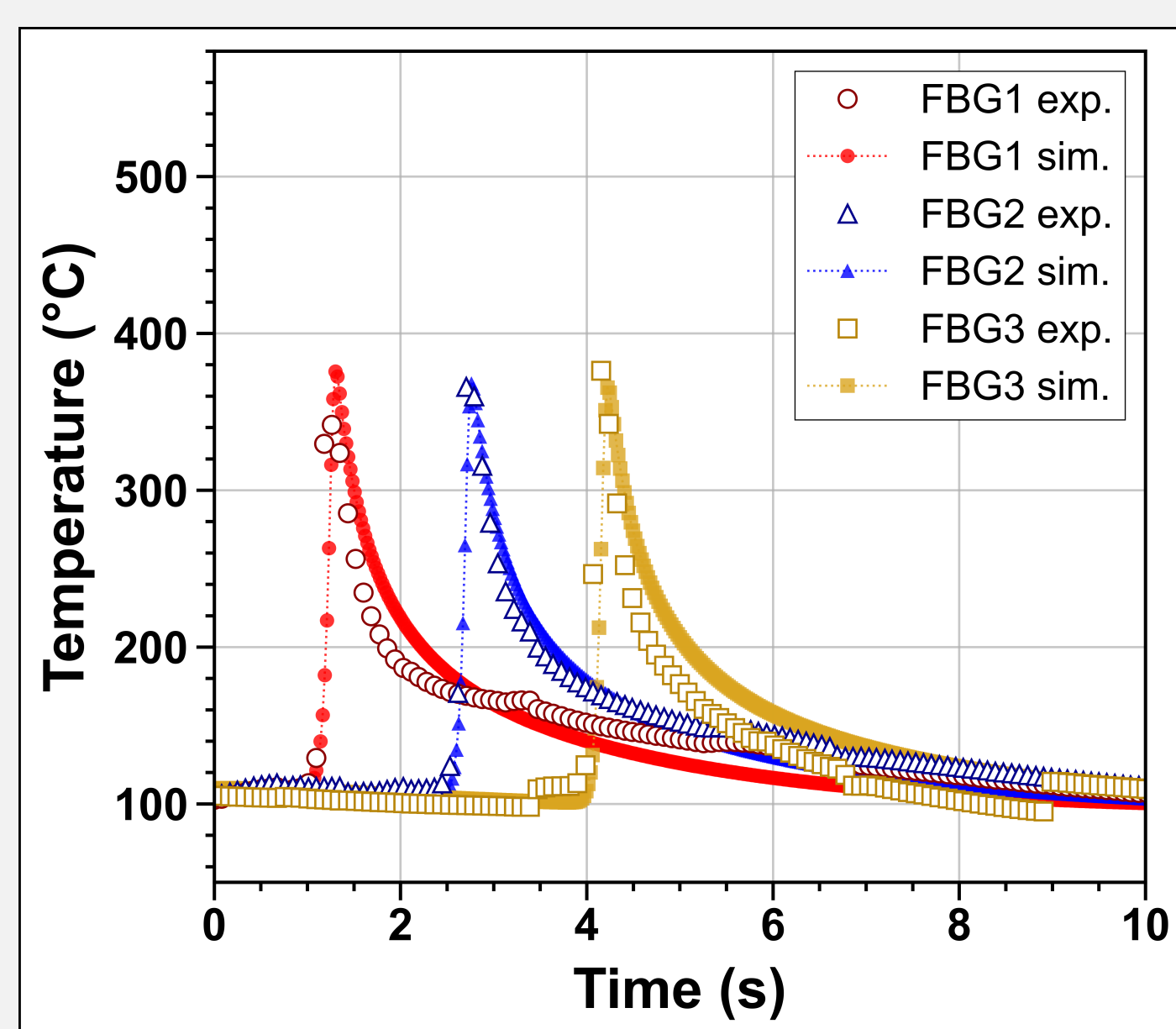
- Discrete gaussian beam → strip of const. intensity
- Powder absorptivity = 100 %
- $v_{\text{strip}} = 9.2 \text{ mm/s}$
- No phase transition
- Bulk material (no capillary): T extracted at FBGs positions
- h_2 adjusted between $1000\text{--}4000 \text{ W m}^{-2} \text{ °C}^{-1}$



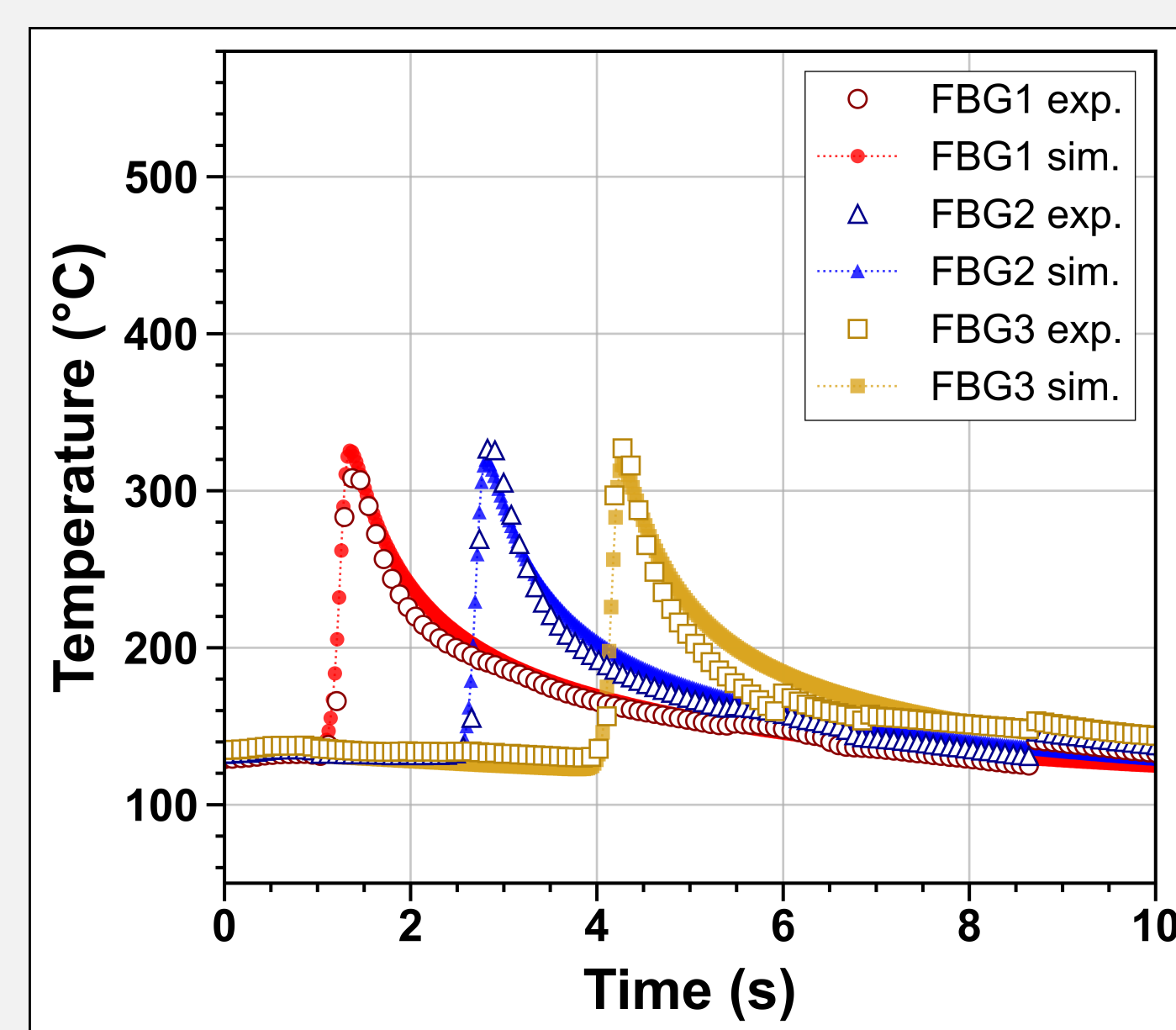
4. Results



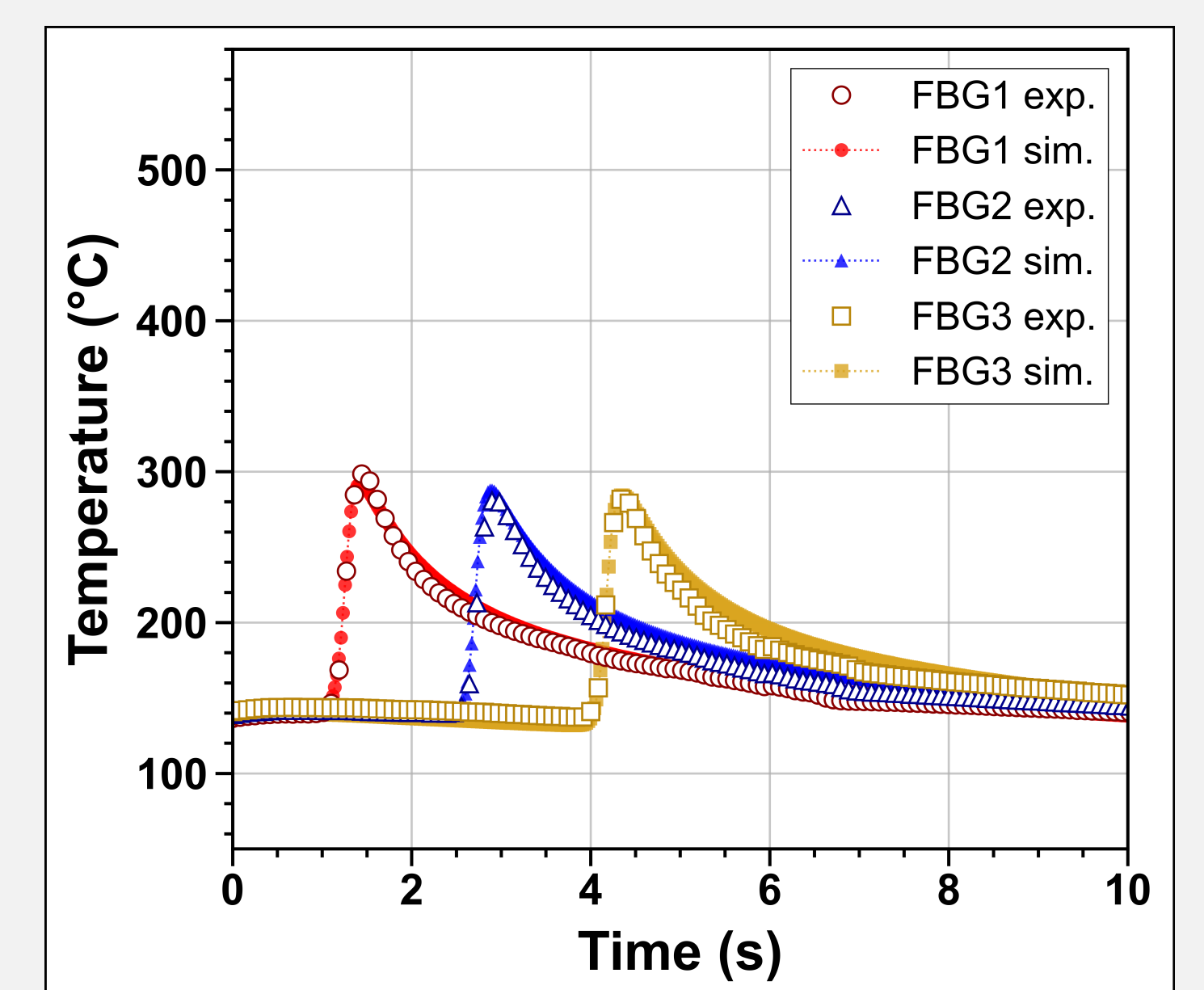
Layer #11



Layer #30



Layer #45



Layer #60

- Satisfying temporal fit between experimental and calculated values
- First layers: error of $\approx 20\%$ in T_{max} → Model too simplified in these early steps
- Layers ≥ 30 : Errors $< 10\%$

4. Conclusion

This work highlights the possibility of modeling the raw thermal dynamics of the L-PBF process using a very simplified model only taking account the main thermal fluxes at stake. Even by simplifying the embedding strategy of the FBG transducers (no capillary modeled), the calculated temperature values are in the order of magnitude of the experimental results, even in the presence of strong temperature gradients, characteristic of the process.